PRACTICAL COTTON MANUFACTURE

SNELL.

Institute any work belonging to the second class, subject to the following regulations:—

Section 1. Every person, on borrowing a book, shall sign a conditional bond, or obligation, for the sum of FIFTY DOLLARS, as security for his due observance of the rules of the Library, and for the value of such books as may be injured or lost by him.

Section 2. No individual shall be permitted to have more than two books out at one time, without a written permission, signed by at least two Members of the Library Committee, nor shall a book be kept out more than two weeks; but if no one has applied for it, the former borrower may renew the loan: should any person have applied for it, the latter shall have the preference.

Section 3. A fine of ten cents per week shall be exacted for the detention of every book beyond the limited time; and if a book be not returned within three months, it shall be deemed lost, and the borrower shall, in addition to his fines, forfeit its value.

Section 4. Should any book be returned injured, the borrower shall pay for the injury, or replace the book, as the Library Committee may direct; and if one or more books, belonging to a set or sets, be lost, the borrower shall pay the full value of the set or sets, and may take the remaining volumes.

ARTICLE 7. Any person removing from the Hall, without permission from the proper authorities, any book, newspaper, or other property in charge of the Library Committee, shall be reported to the Committee, who may inflict any fine not exceeding Twenty-five Dollars.

ARTICLE 8. No Member, whose annual contribution for the current year shall be unpaid, or who is in arrears for fines, shall be entitled to the privileges of the Library or Reading Room.

ARTICLE 9. If any member shall refuse or neglect to comply with the foregoing rules, it shall be the duty of the Actuary to report him to the Committee on the Library.

THE

MANAGER'S ASSISTANT:

BEING A CONDENSED TREATISE ON

THE COTTON MANUFACTURE,

WITH

SUITABLE EXPLANATIONS, &c.:

TO WHICH ARE ADDED,

VARIOUS CALCULATIONS, TABLES, COMPARISONS, &c.

OF SERVICE TO THE

MANUFACTURER AND GENERAL READER.

BY DANIEL W. SNELL.

"And for this new and most prolific source of wealth, we are indebted to the extraordinary genius and talents of a few individuals."

"Can we have a more exciting example, then, of what resolute mind may do in apparently the most hopeless circumstances?"

HARTFORD:
PRESS OF CASE, TIFFANY & CO.
1850.

TO

DANIEL SNELL,

THESE PAGES ARE MOST RESPECTFULLY DEDICATED,

AS A FAINT EXPRESSION OF AFFECTIONATE REGARD,

FROM THE AUTHOR.

PREFACE.

In the following pages, the author has aimed at practical information rather than originality, and has therefore availed himself of the labors of others, whenever they would serve his purpose. Many points under consideration are treated in a different manner from what has been noticed elsewhere; while others are condensed and practical in their arrangement. His object was to give a work better suited for circulation, than the volumes which have appeared on the subject.

Many who do not feel interest enough in the subject, to buy and read so large a work, for instance, as the inimitable Dr. Ure's, or Montgomery's admirable treatise, will read such a work as this.

Due notice has been given of the various machines employed, their improvement, speed, &c., and such other features as were deemed practicable; to which are added numerous tables, calculations, &c.

Each step is explained and may be clearly understood by those who have but a limited knowledge of the art.

Such a work has long been a desideratum with our managers and overseers; and we trust they will not be slow to appreciate it.

Most of it has been the labor of the author while engaged in his duties, and this is his excuse for its not being more worthy of patronage. Nevertheless, as a work, it may not be wholly impracticable, and is given to the public, with diffidence, for the want of a better.

PLAINFIELD, CONN., 1850.

CONTENTS.

THE

COTTON MANUFACTURE

AND

MANAGER'S ASSISTANT.

THE SCUTCHER OR WILLOW.

The operation of this machine serves to open and prepare the cotton for the Lapping or Spreading machine. If we could receive the cotton direct from the field, it would be found that the use of this machine might be dispensed with.

But the cotton, when gathered, being compressed very strong to cheapen its transportation, becomes matted close, and its fibres completely entangled, so as to resemble an uniform fleece of knots or tufts. Nothing could be more injurious, both to machines and the quality of the work, than to use the cotton in this state.

The Willow is peculiarly adapted for the opening of these fibres, and cleaning the cotton from sand and other impurities.

Previous to the stock passing through this machine, a suitable quantity is spread upon the floor near by

forming an uniform proportion of the different quality, strength and length of staple.

Different managers entertain various opinions *how* this quantity should be formed to make uniform yarn.

The general way is to open quite a number of bags and spread them one by one over the whole surface of the lap or bing—each layer forming a part of the desired section. When a sufficient number of these layers are placed upon each other, the lad who tends the machine commences his task, by taking the layer on the top of the bing, and presenting it to the operation of the Willow. When he has run through this layer within his reach, he takes the next and serves it the same, and so on for the rest. In many mills, the bing is formed in the same way as above, and a kind of instrument similar to a rake is used to pull down the fibres at the side. This opens, and in a degree mixes the different qualities. Great care should be taken, and much skill is required in mixing stock, so as to improve the short and weak in staple, and combine the whole successfully for making perfect work.

Much injury, in many mills, is done the soft loose-stapled cotton, by too much scutching. Short, open cotton, requires but little operation until the lap is formed, and often the yarn and goods are improved by omitting this operation, particularly on New-Orleans, Boweds and light Uplands. Long, curly cotton, and that full of seeds, gins, &c., require more opening; but too much of the *tearing* process injures the filaments.

It is not so much the tearing or hatcheling of stock, as the loosening of the fibres, and the separation of gins and other impurities, that is practicable. It is obvious that different qualities of cotton require different degrees of scutching. To pass loose, open cotton through the same process of scutching as close, knotty Upland, would materially injure the former; and to pass Sea-Island, or New Orleans with short inferior Upland, would produce anything but a desirable evenness of yarn. And yet this is too common a practice in very many of our mills.

When but two kinds of cotton are to be mixed, (and most managers deem this number sufficient,) a very good way is to incorporate them by an apparatus attached to the doubler, or lapping-machine, or by passing the two different laps through the same card. This latter way is practised in many mills, and it forms an uniform and beautiful sliver; where two or more spreading machines are employed, it is found to be much cheaper, as a poorer quality of stock can be worked into weft yarn.

The best of cottons, such as Sea-Island, New Orleans and Egyptians, are generally opened by the labor of the fingers—women and children being employed. A quantity is thinly spread upon a table fitted with rods, or strung by cords drawn across; through which the sand, seeds, &c. are made to drop by striking upon it with suitable rods—the elasticity of which aids in opening the fibres. In this way most of the impurities are separated. When the cotton is removed, the gins, leaves, &c. which may have re-

sisted the action of the rods, are carefully taken away. But a small portion of our mills work these qualities. Principally coarse and medium yarns are made, requiring a fair quality stock.

Various machines have been presented for opening and preparing cotton. The most ancient of which we have any account is that of Normandy. It consists of a long round box made of slats fastened to the inner circle, so nailed as to leave interstices between the rods for the escape of all impurities. In some, these slats or rods run round the cylindrical box. An axis extends through this box, with cross-arms so secured as to form a line long in extent round the axle. One end of the box is higher than the other, forming an inclined plane. The cotton is thrown into the box at the top, and the axis, in its rotary motion by means of its arms, catches hold and carries it round the length of the machine, and gently drops it at its lower end. It is quite simple in its construction, and requires but little power to move it. This machine, however, has been superseded by those of more modern construction.

Another machine, partaking of the nature of the above, has been introduced in some mills. It consists of a large cylinder set full of spikes passing between other spikes fixed on the front of the machine. The cotton is led by an apron to a pair of rolls, through which it passes to be scrutched or opened. The cylinder revolves rapidly, and the rolls having a firm steady hold upon the web, serves to open and clean the stock admirably.

"Mason's Whipper," is more or less used, but those of more modern construction seem to merit a greater preference. It occupies but little room, and is a powerful machine.

There is another powerful machine in use, called the "Conical Willow," invented by Mr. Lillie, of Manchester, Eng., a gentleman noted for mechanical ingenuity. It is more complex than either of the above mentioned machines, yet it possesses a remarkable power. It consists of the revolution of a cone inside of a concentrix box filled with spikes as in the common willow.

It presents the novel feature of the cotton being drawn in at the smaller, and whirled along to the larger end of the cone, where it drops upon a moving strap, which lets it fall into a binn prepared to receive it. It occupies but little more room than the common square-framed willow. The motions of this truly elegant automatic machine, are a rich treat to a looker-on. One in viewing them, cannot resist the impulse within him to do homage to the spirit of improvement which has effected a result truly so wonderful in comparison with that of the primitive willow of Normandy, patented in 1801.

The "Bacon Willow," is an excellent machine, and a decided improvement in this branch. It is the most practicable in use for opening and preparing cotton.

LAPPING OR SPREADING MACHINE.

It is a fact well known by our competitors, if not acknowledged by us, that the opening and mixing of cotton is not so faithfully performed in this country as our interest requires.

That spirit, which is our characteristic, of *driving* what we undertake, too extensively prevails in the preparing of stock previous to its being spun into yarn.

The chief machine now in use for forming a lap, is that invented by Mr. Snodgrass, of Johnston, in Renfrewshire; this has been improved by Mr. Cooper, of the same place.

In this, as in all improvements, the mechanics of New England are formidable rivals of the mother land. There are no machines of this, or indeed of any kind, which are more perfectly adapted to their office than those turned out by the Messrs. Whitins, of Mass.

The movements of this machine are full of variety, and show most conclusively the triumph of genius. The cotton is regularly weighed and evenly spread upon the apron which carries it forward to the rolls; of these there are two sets. As the stock passes through these, it is struck by a beater of two or more blades, which revolves with a rapid speed; this opens the fibres, and winnows the gins, seeds, &c. from the cotton. These impurities are thrown back through an opening of the box by the action of the beater.

Directly in front is a large wire cylinder, which receives and carries forward the fleece to another set of rolls, through which it passes, when another beater strikes it; this opens and winnows still more the cotton. Three and often four of these beaters are used. It is an excellent practice to double the lap at this process. It equalizes the fleece and is much better prepared for the Carding Engine.

There is a limited draught between the feeding rolls, for the purpose of stretching or drawing the stock in its operation. Too much of this operation, however, is injurious at this stage, as the fibres are not uniformly straight.

After escaping the rolls and beaters, the web is run through two pairs of calender rolls, to smooth and compress it. As it leaves these rolls, it is wound on a wooden lap-roll, forming a compact and beautiful lap.

The beaters require to be adjusted with precision. In using long-stapled stock, the arms are set a greater distance from the rolls, to prevent the fibres from being injured or broken. This point should be particularly adjusted. The most devoted attention is required by the tender, as the beaters run at a high speed, acquiring great friction, especially when a heavy lap is formed. The sand or dust of coarse cottons tend to clog the bearings, by inspissating the oil. The beater boxes are generally made of fine composition.

This machine, though somewhat complicated, requires but one hand to tend it. It occupies a space

of some twenty feet in length, and from three to five in breadth.

Previous to the introduction of this machine, much poor work was made, arising from an imperfect spreading of the cotton.

Cleanliness of its parts, and expertness of the tender are very essential points to be regarded at this process. In viewing its operations, one cannot but mark the contrast it presents when compared with the old way of spreading the locks upon the apron of the breaker carding engine.

CARDING ENGINE.

This machine opens and equalizes the fibres still farther, and removes in a degree whatever gins, &c. may have resisted the action of the Willow and Lapping machine. The theory or principle of carding, is the alternate action of the surface of sheets set full of elastic wire teeth. These sheets are uniform in their thickness and in their length of teeth.

The lap is led through a pair of fluted rolls, (sometimes they are covered with wiry teeth,) when the small cylinder called the licker-in, opens and delivers it to the main cylinder. Resting on the top of this cylinder are smaller ones, serving to clean and straighten the filaments called by different names, such as cleaners, strippers and urchins. The vacant

space on the top is filled up by flats or slats, upon which are fastened sheets, which aid in keeping what impurities may have passed these cleaners from being carried over to the doffer. In some cards nothing but these flats are used to resist the gins, &c., and aid in equalizing the fibres.

The doffer revolves with a slow motion, taking from the main drum the finest of the fleece, and the comb in front strikes and causes it to wind on the lap-drum or pass through a pair of calender rolls, into a can or guide-box of the railway. This is one of the most beautiful operations in the process of manufacturing, and is the contrivance so unjustly claimed for Hargreaves, in the suit against the ingenious and persevering Arkwright. The feeding rolls are secured at each end by weighted levers. Motion to them is communicated by a range of wheels from the main drum axle, or by a rod from the doffer shaft. The top-slats rest upon the arch or frame of the engine, near in contact with the main drum. The distance berween the tops and cylinder is regulated by screws in each end of the frame work. In ordinary carding, those nearest the front rolls are about three-sixteenths of an inch from the main drum sheets, and the rest decrease from this to one-sixteenth of an inch, or thereabouts.

In many cards two laps are led through the rolls. This is an excellent way of mixing the qualities of stock, and perfecting the card-sliver.

The railway system, (which is a great improvement) is generally in use. This consists of a drawing

head, fed by the slivers direct from the card. An endless band, running in a trough, for the reception of the slivers, brings forward the strand to the rolls, where it undergoes more or less extension, as may be practicable. Some managers deem a limited draught, others a considerable, the best way. At this process, the strand can be drawn, in our opinion, with advantage, the latter way.

Where a railway is used, an independent motion drives the doffer, and on many cards the feeding rolls.

Between the breaker and finisher cards a machine is used in some mills, denominated a doubler, for forming the lap for the latter engine. The slivers from the breakers are run through a set of calender rolls driven by wheel work, which serve to compress and wind the lap. The lap-roll is weighted at each end by weights suspended on the cross-bearing of the loops, which rest on the end of the axis of the roll. When the lap is formed of sufficient size, a lever projecting from the cross-bearing is raised, when a hook is made to catch hold and retain it until the lap is broken off and a new one is replaced. Suitable guides are placed in front of the large rolls for separating and directing the slivers passing through them.

Another machine for the same purpose has been presented, which performs its office admirably. It is of a harrow-like appearance, similar wheel work being employed at the wider end as in the above machine. The ends to be formed into a lap, are drawn by the motion of the rolls into one side of the frame. In this machine the slivers commence entering the rolls at

the narrow end. Rolls of the required length compress these slivers as they pass to the other extremity. This process equalizes in a great degree the lap at this stage. It has the advantage of doubling, and is a much better way to join the filaments.

In some of these machines, a stop-motion forms a novel feature in its operation. When one of the ends are broken, or run out, a guide-lever falls which operates upon a catch or spring so as to shift the belt on the loose-pulley, or along on the axis upon which it freely revolves. It is obvious that this is preferable to the first mentioned machine. The lap formed in this way is passed through another set of cards, going through the same operation as the breakers. The sliver or end formed by the different finishers, is drawn down more than that of the breakers.

Various drawing-heads are in use; some delivering the end into two or three slivers, which are compressed by calender rollers and delivered into cans ready for the drawing-frame. Motion is conveyed to the rollers by an endless band passing round two cones, their ends being inverted. It is not uncommon in some mills to regulate the size of yarn by shifting this band alternately as may be required. Another advantage over the old way of carding is here gained; when the cylinders require to be stripped or cleaned, all that is necessary to be done is to shift the belt, and stop one card of the system and clean it, put it in operation, and so on for the rest. This, it will be seen, ensures steady, uniform work, and prevents the many

stoppages attendant in the operation of cards mounted with the old fashioned lap-drum.

In many mills, instead of a drawing-head and a single trough, there are two, three, and sometimes four of these troughs which convey their proportion of the sliver to the first head of the drawing frame. I have seen this working well on a system of twelve cards; the drawing frame being placed so as to receive these slivers about midway of the range. No improvement has ever been introduced into the preparation department, which has proved more beneficial, or productive of more return than this railway system. It takes less power to drive it, makes more and cleaner work, does it quicker and more perfect, and with less expense than by the old way.

Where eight to ten children were employed in tending the old fashioned lap-drum, there is but one small boy required in using this admirable improvement.

Single carding, or cards where the cotton passes through but one operation, is much in use in many mills, particularly on coarse work.

These engines, when properly managed, furnish good carding, but most of carders seem to agree that the breaker and finisher are better adapted for furnishing an uniform sliver. Various patterns of mounting are in use both on the breaker and single carding engines. The common breaker card generally has nothing but flats, or flats and a licker-in: a second way is a licker-in, flats and cleaners, while in some no slats are used; the surface being literally covered with urchins of two or more sizes.

Many experiments, but less real improvements, have been made from time to time upon this machine.

A kind of fancy, similar to that used in woolen, is often used in cotton cards, for the purpose of cleaning the main cylinder. By the use of this, much labor is saved, as but once or twice cleaning of the main drum is necessary in a period of twelve hours.

In many carding engines, it is not uncommon to have two doffers acting in concert upon one drum. These do quite well on large heavy machines.

Frequently the main drum is made of sheet or cast iron, coated with a composition of chalk, glue, &c. Upon the former are fastened cast iron plates, fitted to its circumference, with strips of wood between, for confining the sheets or fillets. A better way, however, is employed in the latter; the cylinder is turned perfectly true, and suitable holes are drilled therein and plugged with hard wood for receiving the nails of the sheets.

This kind of cylinders are objected to by some, on account of their great weight. They are a perfect cure for the shrinking and swelling of drums, so much the pest in many mills.

In some cards, a blade is made to rest near in contact with the main drum, directly under the top nearest the doffer. It is bent so as to catch what gins, dirt, &c., may fall upon it; a small roller receiving its motion from the doffer shaft is made to turn in this blade, so as to wind on the loose fibres, &c. caught by it.

This is a greater improvement than at first it might

seem. I tried one of them on an eighteen inch card, the small roller revolving some six or eight times per minute, and during a run of but three hours, this roller was cleaned twice, and the astonishing quantity of *ten ounces of the poorest waste made in the whole process of manufacturing* was turned out. This, in a system of fourteen or sixteen cards, would amount to more dirt and other impurities, (exclusive of flowings and waste,) than all the urchins, slats, and licker-ins could, in the same time possibly clean out: this blade placed upon the whole range would take out from eight to nine pounds of this waste, unfit for any use, in the short space of three hours—being well nigh thirty-five pounds in a working day of twelve hours. That a result so great in its importance should spring from so simple a contrivance, might well be discredited, if it could not be substantiated by a fair trial. This blade is stationary, and turned up at its top or edge, (being in close proximity to the main drum) creates a current of air, which serves to throw out these impurities from the main drum, and deposite them on its hollow part; the roller revolving quite slow, keeps the impurities from flying back again to the surface of the drum, and winds them into a fleece to be removed when large enough.

Various other improvements are to be found in operation on many of the engines made at this time, which reflect much credit upon their authors. Long cottons require more carding than short, and in many cards, the feed rollers of the former are made to revolve with a slower speed, or the main drum is driven

quicker than in those of the latter. The main drum ought to run as near the feeding rollers as possible, serving to have the better hold of the fibres.

The feeding rollers ought to be in diameter *a little less than double the length* of the staple to be carded. In this way the teeth will take hold of each fibre separately, and deliver it to the top slats as it was taken from the rolls.

A regular system of cleaning and stripping is of essential importance. The common mode is to strip two, three or four slats on one card, and so through the whole system; then to commence again on the first card, repeating the operation the third or fourth time if necessary. This course pursued, the top slats will better clean and separate the gins, &c. from the main drum, and uniformity of work is obtained.

Other ways are preferred at the option of the manager. Some strip every alternate top: thus, the 1st, 3d, 5th and 7th, then the 2d, 4th, 6th and 8th, and so on for the rest; while many think this the most practicable, viz., the 1st, 4th, 7th and 10th, &c.

The mode of grinding is various. In many modern mills an ingenious machine is used consisting of a small cylinder some four or six inches in width, made to traverse alternately from the right to the left, and vice versa. This performs its office with much precision, and is coming into general use.

The old mode, however, is as yet more or less used. It consists of a simple revolving wood or iron cylinder covered with emery, which is made to bear gently against the card to be sharpened. Frequently a board

or cloth coated with emery, is held upon the main and doffer drums for the same purpose.

Where the top slats are held by the hand to be sharpened, the utmost care and steadiness are indispensable. This, however, is done much better by the machine above mentioned.

An uniform temperature should be maintained in the preparation department. In many mills this is accomplished by the use of steam. This mode, while it regulates, also purifies the air.

The sheets are distinguished by the number of teeth in the breadth of wire—three and a half inches for the cylinder, and two for the top sheets—twenty of these are in an inch, forming a crown: hence there will be 70 teeth in the cylinder, and 40 in the top sheets. Explanation of the fineness of the sheets of different carding, is given in Table X, under "Various Tables, &c."

In a treatise like this, it will not be expected that all the features and technicalities of the art of carding will be explicitly delineated. All practical carders are aware, that a train of ideas instructive in their nature, and almost illimitable in extent, are the result of experience and investigation.

No machine employed in the art of cotton manufacturing, is more important, or deserving of greater study,—no machine which performs more admirably its operations—so delicate in their nature and so triumphantly perfect in their adaptation; no machine which does greater homage to the ingenuity of man,

and which yields, in a greater degree, a more productive result, than the carding engine.

To behold the movements of a system of these machines, full of activity and obedience, is to gaze upon so many offerings of the reward of genius to those master-spirits, who gave birth to features so feeble in their beginnings, disasters and struggles, but which, like the sturdy oak planted in a rugged soil, have flourished and become mighty.

A stranger gazing upon the crank comb-motion, of inimitable beauty, cannot but reverence the spirit of invention, which presided in the bosom of that great man, Richard Arkwright, *its inventor.*

In his astonishment that so important a mechan ism—so practically philosophical, should have for its author a poor factory boy, he imagines every stroke a vibration of homage and respect meted out to him by the innumerable representatives of his sagacious mind and irresistible genius.

DRAWING FRAMES.

This machine serves quite a different purpose from the Carding Engine. Its office is to elongate the end or sliver delivered from the card, or railway drawing-head, to straighten the fibres, and lay them side by side parallel to each other. Its operation serves to

make even the whole work by uniting many ends into one, and to draw down the sliver previous to its being run through the fly or roving frame. The fibres of the end formed by the cards are not perfectly straightened by that process, being doubled or crossed on each other. When properly managed, the drawing frame straightens these filaments.

Among its principal features, are the top and bottom rollers; the former are covered with suitable leather, highly coated with a kind of varnish, to render them perfectly smooth; the latter are somewhat larger, and fluted so as to retain a firm hold upon the tender filaments. Most frames have three pairs of these rollers in front of each other, in one position, placed at proper distances as the length of staple may require.

The bottom rollers are driven by wheel-work, with different velocities, adapted to the length of draughts required. The top rollers are driven by the friction of the flutings of the bottom rollers.

In some frames of recent construction, four pairs of rollers are used, serving to give three draughts.

Another feature of this machine is the roller-beam, which supports the several heads. The front roller-stand is stationary, but the middle and back roller-stands can be moved so as to come near, or recede from, the front roller, or each other, suiting the different staples of cotton that may be used. This is an important improvement in all roller machines, and one which has not been very long in use in this country. The top rollers, driven by the friction of the flutings,

rest their ends in the stands, and a suitable weight is made to bear them down in their middle by a wire, which holds firm upon them a wooden or brass bearing. Most commonly the front roller is weighted separately.

Top brushes, made of suitable wood, and covered with cloth, rest against the top rollers to keep the surface smooth, and retain what impurities may have lodged upon them. In some frames, brushes compressed and held by a spiral spring, rest against the bottom rollers for the same purpose. The slivers to be drawn, are introduced to the back rollers, being separated by projecting pins from a cross bar. Sometimes two or four of these ends are run through the rollers, and drawn into one end. The end thus drawn, with increased doubling, acquires uniformity, and is well prepared for making even and perfect work.

To draw the last end to its grist, in one operation, would illy perform its required office, arising from its great attenuation. This is done by degrees, while passing through the several heads ; the second serving to draw the first, the third the second, and so on for the rest. As many as eight heads are in use in some frames, but for common numbers not more than three or four. Different carding masters have as various views respecting the number of doublings, and extent of draught to be given the cotton ; some preferring but a few of the former, and others many, for the same quality of work. In most frames in this country, there is not a very extensive number of doublings, from the fact that most of our yarns are coarse and

medium numbers. On very fine work it is common to extend the number as high as 100,000; this quantity is deemed sufficient for any number of yarn whatever.

Excellent coarse yarns are made from roving of only sixty-four doublings.

The different qualities of stock used require more or less doubling, as the manager may direct.

Long straight cotton, whose filaments are uniform, requires but a few, while curly matted stock requires more doublings. It must be obvious, that a uniform quality of stock should be used.

It is not uncommon however, in many coarse mills, to mix cotton of different length of staple, from the shortest Upland to fair New Orleans, and pass them through the same operation. Now a little reflection will convince us that nothing more injurious could be done to the whole; the longer fibres in passing through the lapping machine would be broken, the short would not combine, the stronger would throw out the short and weak in carding, and much stock go to waste; in the drawing and roving processes it would be impossible to draw the filaments to an uniform sliver; besides, extra labor is required, poor work obtained, and thereby the credit of the manufacture impaired.

Many managers approve of mixing a number of qualities of cotton, but in our opinion two are sufficient, and one is more practicable to make an even warp. Where the preparation is ample, and two systems are employed, it is an advantage to use two qualities, one for warp and the other for weft. This

practice is coming into use, and is found to be cheaper, as a poorer cotton, (as previously intimated) can be run into the weft yarn. This presupposes the different machines adjusted to suit the staple of cotton used.

In some drawing frames, a double roller beam, and therefore a double draught at the same doubling, has been introduced ; this does well on coarse, but answers not so well for medium or fine numbers. In many frames, the draught or extension of the sliver is the same in the several heads.

In a frame of four heads, the three first putting up six, and the last four ends, and the draught in the proportion of 4.75 to 1, we have this ratio:

$$\frac{6 \times 6 \times 6 \times 4 = 864}{4.75 \times 4.75 \times 4.75 \times 4.75 = 517{,}57} = 1.66$$

Then with 864 doublings, the sliver is 1.66 times stronger. Suppose it weighed No. $25 = \frac{25}{1.66} = 15{,}06$ showing that many more fibres are compressed and formed in the last sliver, from their being drawn and doubled.

Various improvements have been made upon this machine, some of which are enumerated.

The cans which receive the tender slivers from the rolls, are made to revolve slowly : this lays the drawing more carefully than the old mode. Some cans fill from the bottom, and many other ways are employed for this purpose. The most practicable machine for this purpose is furnished by Messrs. Dean and Morse, of Taunton, Ms. Large cans are coming into gen-

eral use; they save much bad work, piecing and labor.

In many frames the front roll is made quite large. This though a novel, is an excellent improvement. The draught of each head is increased or diminished by changing the front roll wheel or wheels, denominated "change wheels."

Another feature in the class of improvements is the stop motion. It consists of a rest or guide supported by a rod or pin, upon which it is nearly balanced, requiring only the weight of the sliver to make it stand perpendicular. As the end breaks, this rest or guide drops down, and a projecting point bears upon the rod which turns partly round, another point presses a catch, this catch turns on its stud, when another point is lowered, and permits a rod to be forced ahead by means of a spiral spring, which serves to move the lever, through which runs the belt. This is quite an ingenious invention, and serves its purpose quite well.

By the introduction of the large cans and this motion, better, and at the same time, cheaper work is obtained; a saving of one or two hands is made, and frequently in mills where the drawing is but lightly drawn and adapted for fine work, it is not uncommon for a small girl to furnish drawing for eighty or a hundred looms.

There have been introduced in some mills, a mechanism to equalize the grist of the drawing. It appears to be practical, and promises to answer its purpose. Still as an invention it admits of improvement. It

strikes us that the regulator-rod should be more properly adjusted.

Some other novel features are to be found on a number of frames, ingenious in their construction and quite serviceable in their office, among which is "the Coiler and Winder," a decided improvement.

Close attention to the working parts is required, and an uniform degree of friction ought to be given the rollers.

All the bearings ought to run as perfect and easy as possible, and cleanliness in this, as in all of the branches, demands its deserved supremacy.

The rollers ought not to be too heavily weighted on light work—this, in all drawing, is a point which experienced carders know, requires judgment and care. A new mode of weighting the drawing is in use on many frames: it consists of a lever, upon the end of which is a ball, movable by means of a set-screw. This serves its purpose admirably, as the weight required by the different grist of drawing and change of weather, can easily be given by moving the ball to the right or left.

The spirit of invention, so prevalent in our day, seems to have thrown its mantle upon us as a nation, and no where in a greater degree do we behold its fruits, than in the progress of the art of Cotton manufacturing. This is clearly seen by contrasting the beautiful machines, so full of seeming magic power, of our own day, with those of Arkwright and Slater, so rough in their appearance, and, at best, imperfect in their operation.

ROVING FRAMES.

The next machine employed in the process of manufacturing, is the Roving Frame. It serves to draw the drawing-sliver down to a proper grist, and give to it a small degree of torsion. The greatest care is required at this stage of the art in preserving the uniformity of the rove, as upon this depends the evenness of the yarn.

Various machines have been presented to the notice of manufacturers for performing this operation. The most important of them will be noticed; and first, the Eclipse Roving Frame.

This machine produces good rovings, and is much in use in spinning coarse numbers. It is quite simple in its construction, occupies less room and takes less power to drive it than any other rove frame I have ever seen.

The ends as they descend from the rollers, are condensed by the opposing surfaces of a traveling endless belt; another similar belt, upon which rest the spools, serves to wind the rovings.

This machine is capable of being driven at a very high speed; the front roller frequently revolving from seven hundred to seven hundred and fifty revolutions per minute. There are but ten spools in these machines, but from five to six hundred hanks per day can be turned out with ease.

There are some objections made to these machines, some of which are their liability to collect considera-

ble dirt, &c. in their operation, and the tendency of one end catching on and revolving with those nearest it. Still they are an astonishingly productive machine, and answer quite well for coarse and medium work.

Another machine which has been presented, is the Tube Frame, sometimes called the Taunton Speeder, and Dyer's Frame; this latter name is more common in England, being the name of the gentleman who patented it there in 1825.

The principal features wherein it differs from the Eclipse frame, are its complexity, and in its mode of twisting or condensing.

In some of these frames two rows of spools form quite a novel feature. These perform their office very well, but are better adapted for coarse than fine yarns. The rovings made from this machine, are very similar to those of the Eclipse frame.

Another machine, or rather an improvement on the Tube frame, is in operation in many mills, called the Plate Speeder.

It consists of a pair of friction plates, through which the rove is made to pass, each sliver being provided with a pair. These plates revolve rapidly in opposite directions, serving to twist and untwist the rove in the same way as in the Tube frame.

The surface of these plates do not press against each other more than three-eights of an inch from their circumference; this part is beveled, so as to make the plates nearest the rollers stand from each other in order to bring the bevels parallel; an angle

is thus formed, and the point presses the bobbin, making it to wind firmly. These plates are so constructed that they may be used for coarse or fine work.

Some carders like them well, but it is generally acknowledged that the Taunton and Eclipse Roving frame, are better adapted for making a more uniform rove, and for turning out a greater quantity in a given time.

In some mills, a machine denominated the Double Speeder, is used for making rovings. It is somewhat complex in its construction. The drawing is passed through a set of rollers, where it undergoes a suitable draught, and is made to receive a slight degree of twist by the spindle below.

The rovings formed by this, are frequently passed through another machine similar in its nature, having a row of spindles on each side of the frame. These machines, when properly managed, make excellent rovings.

A great improvement on this, and all other roller machines, has been introduced. It consists in the bevel of the rollers, whereby the front will be somewhat lower than the back roller. The twist given to rovings, or yarn, is more properly distributed as it proceeds up nearer the middle surface of the rollers. These machines are similar, though not so complex, as the Bobbin-and-Fly Frame of recent construction.

In many fine mills, a machine called a Stretcher, is used to draw down the rove to its required fineness, performing the operation better than could be done in the Fly Frame.

But the most perfect and beautiful machine ever presented to the notice of manufacturers for making even rovings, is the Bobbin-and-Fly Frame of Messrs. Cocker and Higgins, improved by Henry Houldsworth, jun. of Glasgow, Scotland.*

It is quite complicated in its construction, and displays the ingenuity of its builders, for which they are so deservingly celebrated. It possesses many novel and entertaining features for the study of the philosopher and mechanic, and is generally acknowledged to be one of the most beautiful and scientific machines ever invented. Its various motions and windings, its perfect work, and its almost speaking triumph of genius, are indeed a rich treat to a looker-on.

A better explanation of its features and movements, cannot be given, than that of the noted Dr. Ure, in his work on the Cotton Manufacture of Great Britain.

There are two principal points which claim the attention of the reader—the mode of twisting and the winding-on motion.

Speaking of these the learned Doctor says: "The twisting is effected by the revolution of the spindle to which the fly-fork is attached, while the sliver, in its passage from the roller to the bobbin, proceeds along the arm of the flyer, which, being of one piece with the spindle, revolves with it; the quantity of twist given to the roving depends upon the ratio between the surface speed of the front roller and the revolu-

---

* This machine has been materially modified and improved by American mechanicians. This remark will apply respecting most of British and foreign machines.

tions of the spindles. The winding-on was accomplished in jack frames, by an uniform motion applied by a carrier roller to the *surface* of the roving on the bobbins, which was made to correspond exactly with the surface speed of the front roller; but in the bobbin-and-fly frame it is accomplished by giving to the bobbin such a velocity that the difference between the motion of the delivering end at the arm of the flyer shall equal the surface motion of the roller, or the supply of the sliver. This distinction between the action of the jack-frame (to which, in the winding-on the tube-frame may be assimilated,) and the bobbin-and-fly frame, must be kept constantly in view.

In the bobbin-and-fly frame, the bobbin revolves round the spindle, and not at right angles to it, as in the jack-frame, which circumstance removes many of the objections justly urged against the latter contrivance. The first bobbin-and-fly frames were of a very complicated kind, containing three or four conical drums for producing the several variable motions.

From the position of the bobbin upon the axis of the spindle, it is obvious that every revolution of the spindle or delivering arm of the flyer round the bobbin supposed at rest, or ahead of it supposed in motion, will wind up a length of roving equal to the determinate periphery of the bobbin, the end of the roving being previously attached to it. But as the number of revolutions of the spindle requisite to give the desired degree of twist has no necessary connection with, but, in fact, greatly exceeds the number of turns required to wind up the length of roving delivered by

the front rollers, it will follow that, unless some scheme be contrived for lessening progressively the number of revolutions of the flyer round the bobbin, the roving will be coiled up too fast, and will be infallibly stretched and broken. This scheme cannot consist in reducing the number of revolutions of the flyer, (for these must be proportional to the desired degree of torsion) but in making the bobbin revolve in the same direction with the spindle, but at a speed so much less than it as to cause the circumference of the bobbin to fall behind the delivering arm of the flyer, so that the difference of their velocities shall equal the rate at which the roving issues from the front roller. Thus, if a given length of roving, equal, for instance, to the periphery of the front roller, or four inches, be equal also to one circumference of the bobbin at a certain stage of its increase, then, to wind up this length, the arm of the flyer must revolve several times about the bobbin till it has got ahead of its surface rotation by four inches; and this may be effected either by making the spindle turn once round while the bobbin stands still, or by making the bobbin revolve one turn less than the spindle, whatever may be the speed of the spindle. If the spindle, for example, makes ten turns while the above four inches are given out by the rollers, then the bobbin will require to make nine turns; or, if the spindle makes twenty turns, the bobbin will require to make nineteen. The same result will be produced whatever be the speed of the spindle, provided the difference between the circular space, percurred by the spindle and the bobbin, in the given

time remains four inches. This difference, which represents exactly the requisite winding-on motion, is, therefore, dependent jointly upon the speed of the front roller, or delivering motion, and upon the size of the circumference of the bobbin at the particular stage of winding-on, and is quite independent of the twist or the velocity of the spindle. From the manner in which the first bobbin-and-fly frames were constructed, every change in the twist required a corresponding change in the speed of the bobbin—a change not proportional to that of the twist, but such as would preserve the difference between the motion of the spindle and bobbin as it was, relatively to the roller. Thus if the spindle, turning ten times while the bobbin turned nine times, gave the proper difference of motion $= 1$, for winding-on, then if the twist was doubled, the speed of the bobbin would require to be more than doubled, for, as the spindle would then turn twenty times, the bobbin ought to turn not eighteen, but nineteen times, in order to maintain the same difference of motion $= 1$, as at first.

The object of the recent improvements of this important machine, for most of which the world is indebted to Mr. Houldsworth, has been to get rid of the difficulty of making these perpetually recurring and very intricate adjustments of the speed of the bobbin, which were found in practice beyond the capacity of most overlookers of the preparation room of cotton mills, who seldom arrived at the correct difference till after an expensive and wasteful series of errors and alterations, whereby the quality of the work

was more or less damaged for several weeks at each change of the twist or of the cotton staple.

In the coarse bobbin-and-fly frame, it is usual to make the spindle go quicker than the bobbin, and in the fine to make it go slower, by which the winding goes on backwards. Let us state a case in numbers for the sake of illustration. If 45 inches of roving are to be wound upon a bobbin whose barrel is $4\frac{1}{2}$ inches in circumference, 10 turns will be required. Suppose that these 45 inches should receive 30 turns of twist, the spindle, and consequently its attached flyer, must give these 30 turns during the winding on of the roving. If the bobbin therefore is $1\frac{1}{2}$ inch in diameter, it must make 10 turns for the winding on, and 30 turns in following the spindle; in all 40 revolutions.

If the bobbin be 3 inches in diameter, or 9 in circumference, it must make only 5 turns to wind on the 45 inches; these 5 turns added to the 30 turns required for twist, make 35 revolutions: and thus for any other dimensions of the bobbin. It hence results, that the number of turns of the bobbin, *plus* the number of turns of the spindle, is a quantity always inversely as the diameter of the bobbin. The motion of the bobbin and spindle is simultaneous and in the same direction, with a difference varying more or less according to the variable diameter of the bobbins. But to render the matter still plainer, suppose for a moment the spindle to be stationary; then the bobbin must turn with such a velocity, that it shall wind the roving just as fast as the front rollers deliver it. This

roving comes forward at a uniform rate; but the bobbin growing continually larger in diameter, should turn with a velocity uniformly retarded.

Let us now restore motion to the spindle: it is evident that when the winding is forwards, as in the fine fly frame, we must deduct from the rotation of the bobbin, needed for winding on the roving, that of the spindle required for the twist; for the circumference of the bobbin being $4\frac{1}{2}$ inches, 10 turns take up 45 inches. These 10 turns deducted from the 30 made by the spindle, leave only 20 turns for the effective speed of the bobbin; or, if the circumference be 9 inches, 5 turns will take up the 45 inches, if the spindles be at rest; but if the spindle makes 30 turns for twist, the effective speed of the bobbin will be $30 - 6 = 25$ turns. Hence for the fine bobbin-and-fly frame we find that the number of turns of the spindle, *minus* the number of turns made by the bobbin in the same time, is a quantity inversely as the diameter of the bobbins.

In the coarse frames the bobbin should move faster than the spindle, and its speed should go on diminishing; while in the fine frame, the speed of the bobbin is less than that of the spindle, and it goes on progressively increasing. For this reason the cones of these two machines are set in opposite directions. This arrangement is not, however, indispensable, for the cone might be placed similarly in each; but as the fine frame has a good deal of twisting to perform, the bobbin would need to turn still more rapidly than in the coarse frame, which would consume more moving

force, for which reason it has been found more advantageous to make it revolve in the opposite direction."

For a more faithful delineation and description of this complex and beautiful machine, the reader is referred to the works of this scientific man.

One of these machines, with the improved spring presser attached, forms a striking contrast with the can and jack roving frame, constructed and used by Arkwright.

SPINNING MACHINES.

The spinning machines serve to complete the operation of drawing and twisting. Of these there are many kinds, performing their office with much precision.

The Flyer-frame will claim our first attention. It is quite simple in its construction, and remains much in use.

The roving is passed through a double set of rollers where it undergoes a suitable draught, when the spindle below draws it down and gives to it the requisite twist similar to the bobbin-and-fly frame, though in a greater degree.

As it leaves the front roller, it is led through a guide directly over the centre of the spindle, when it passes round the arm of the flyer two or three times, and through the eyelet, to the bobbin, which, by its friction, serves to wind it firm.

Good yarns are made from this machine, adapted, however, better for warps than wefts. In some, a twist is formed on the top of the spindle round which the end passes before it reaches the flyer; in others, the rollers are beveled considerably, and other improvements are found quite serviceable. These machines will spin from four to four and a half hanks per spindle of 25's or 30's warp in a day.

A machine called the Cap Spinner, or Danforth's Throstle, is somewhat in use in many mills.

Instead of the flyer, a hollow cylinder or cap is fixed to the spindle, which is stationary, the end passing round its lower edge to the bobbin, which is made to revolve by the band running round the wharve of the spindle. A traverse motion is given the bobbin as in the flyer frame. Often weft yarn is spun on this machine, a suitable traveling apparatus being given to the straight bobbin. This machine is capable of being driven at a very high speed, (frequently from 110 to 120 turns per minute,) and of furnishing from five and a half to six hanks of No. 28's per spindle per day; some indeed with conical caps will spin from seven to seven and a half hanks per spindle per diem.

It makes a soft, wooly thread, and is well adapted for fine warps. It presents quite a novel appearance in its operation, as the end is whirled so rapidly round the polished cone, "as to project in space the appearance of a continuous conical fleecy surface, intersected by four vertical lines, coincident with the centre and the two lateral edges of the cone.

Some objections are made to this machine; damp, heavy air serves to draw too hard the end, and considerable waste is made. Yet many spinners think that all of the objections made, are more than balanced by the quantity of work it turns off. It is an ingenious invention, and reflects much credit upon its inventor.

Another machine, called the Ring Spinner, or Ring and Traveler, has been introduced, and gives very good satisfaction.

A steel spring clasp in the shape of the letter C, rapidly revolves round a polished ring, by the turn of the bobbin fixed on the spindle; this is its principal feature wherein it differs from the cap spinner.

Excellent yarns are made by this machine, and it will bear driving at a great speed. I have spun from six to six and a half hanks of No. 28's per spindle per diem on this machine.

The yarn is adapted either for warps or wefts. Many managers prefer to throw aside the mule and use this mode of spinning for both kinds of yarn. As the spindle revolves rapidly, and the thread has no rest or guide but the traveler round the ring, the end is made soft and woolly, and is peculiarly adapted for the transverse threads of cloth.

It requires less power to move it than the old flyer frame or dead spindle, to be mentioned.

The driving bands require to be kept uniformly tight, to prevent their slipping, and making slack yarn.

This is the greatest objection made to them; it

would be well to have a small tightening pully similar to that of the cap frame in this machine.

This is a very productive machine, the front roller ranging from seventy to one hundred and ten turns per minute.

Another improvement presented is the Dead Spindle, sometimes called "Montgomery's Patent Spindle," and the "Glasgow Patent Spindle."

The spindle in this machine has no motion except the traverse motion for winding on the yarn.

The flyer is longer and quite different from that of the flyer frame. Upon the bottom of it is fastened the wharve, which is turned by a band in the usual way. The yarn is wound on the bobbin as in the common throstle, or like the Danforth, on tubes, or straight bobbins.

These machines do pretty well, but are not capable of doing the quantity or quality of work turned off with the Danforth or cap frame. They have, however, many zealous partizans in this and other countries.

Still another improvement upon the spindle is that of Mr. Henry Gore, of Manchester, England.

It consists principally in the bearings or collars; they being made somewhat larger at the lower than the upper end.

This machine requires about one-fifth less moving power than the dead spindle, and can be driven at a higher speed. The common speed of the front roller is from seventy to ninety-five on numbers between 12's and 25's, but it is not uncommon to run them as

high as one hundred or one hundred and five turns per minute.

On common numbers this machine will spin from five to five and a half hanks per spindle per diem.

The Danforth and ring are used both on warp and weft. This latter machine is preferred by most managers, both for the quality and quantity of work it turns out.

One cannot but perceive the marked contrast between the Danforth and ring, and the water spinning throstle, invented and used by Arkwright and his cotemporaries.

Other improvements of the throstle and ring are in the course of trial which are quite flattering, and the day may not be far distant when a machine may be presented capable of eclipsing all we behold of precision, beauty, productiveness and profit. While strides for the climax of fame are so predominant with us as a nation—particularly as an inventive nation—it would be singularly incredulous not to entertain the advancement we have made. Genius, energy of purpose, and persevering devotedness of object, are so preëminently characteristic of the American, that we imperfectly know what invention we should question, or what believe, until frequently we are constrained to acknowledge the practical utility of the same.

The next machine for spinning yarn is the Mule. Generally in this country, this machine is used for making weft, though in some mills where a particular kind of yarn is required, it is common to find both kinds made from it.

Mules of different construction and of all sizes are in operation. No machine has been made the object of more investigation, and attended with more success, than the mule-jenny.

In some, the head-stock is placed in the middle, in others, at one end. Many managers prefer to double two pairs together, one in front of the other, so as to be worked by one hand. Some prefer to lengthen the common mule so as to contain five or six hundred spindles,—one hand running a pair.

Some prefer to have less than three hundred spindles in one mule. Many improvements, ingenious in their design, are to be found in operation on this machine.

The mode of drawing out the carriage presents a novel feature on different mules. Upon some, the scroll-wheel is composed of two grooved circles, fastened to each other by means of screws, so as to suit itself to the different length of stretch that may be required for the same, and different number of yarn.

Counter bands, to prevent the slip of the drum band, are coming into general use.

Weights to draw out, and to aid the spinner in putting up the carriage are much in use, relieving the labor of the spinner materially. Indeed, it would not answer our purpose in this little work, to name all the improvements which have been brought forward to the notice of the spinner; nor would it profit the reader without suitable explanations.

Different spinners drive their mules at various speeds; some prefer sixty and seventy as the means

of the front roller speed per minute ; others, sixty-five to eighty, for numbers between 14's and 30's.

It is not uncommon in this country to run mules from four to five stretches of fifty-four inches per minute, on numbers from 20's to 30's ; this is much quicker than mules are driven in England and Scotland, on the same numbers.

It is generally acknowledged that, on numbers from 14's to 30's, (being the numbers generally spun in this country,) we produce more yarn than our foreign competitors.

A better quality of stock is generally used in this country on common numbers than in Britain. And it is not saying more than can be substantiated, that we make a cheaper and better article of common goods than our experienced rivals of Manchester.

One in the time of Slater would have thought it a preposterous idea, that, in a period of less than forty years, from a beginning so feeble, we should be able to compete with adversaries so formidable.

The spirit of genius, so untiring in its progress, which has presided in the breasts of those master spirits who have so well acted their part, has let fall its mantle upon those of our day who have proved themselves worthy of its protection and dignity. In proof of this, we refer the reader to the construction and operation of the great invention of the age in the art of cotton manufacturing,—the self-actor mule.

This machine, so complex, so ingenious and perfect in its construction, and so beautiful and concise in its operation, has, after repeated trials, been perfected.

The attention of mechanicians for a long time had been directed to the attainment of an apparatus which would dispense with the labor of the spinner, or render the mule similar to the throstle frame,—requiring no manual labor to operate it, except the piecers to piece the ends, fill the creels, and keep clean the working parts, &c.

William Strutt, Esq. of Derby, is said to have been the first contriver of the self-actor mule; not many, however, were ever put in operation, owing to the want of necessary skill and workmanship at the time of the invention. This gentleman was eminently noted for his mechanical ingenuity.

In the work of the noted Dr. Ure, on the Cotton Manufacture of Great Britain, is a faithful exposition of the origin, progress, and present state of this machine. The reader is referred to the same for information on this and all other machines used in cotton manufacturing.

Speaking of this machine, the writer says on page 196, vol. II:

"Of the various attempts made to accomplish an object of so much importance to that great branch of business, cotton spinning, the inventions of the following parties only have been put into operation beyond the purpose of experiment; viz. Messrs. Eaton, formerly of Manchester; Mr. De Jongh, formerly of Warrington; Mr. Buchanan, of the Catrine works, Scotland; Mr. Brewster, of America; Mr Roberts, a partner in the firm of Sharp, Roberts & Co. of Manchester; and Mr. Knowles, of Manchester.

Of the self-acting mules invented by Messrs. Eaton, ten or twelve only were put in operation in Manchester, and at Wiln, in Derbyshire, and a few in France; but from their great complexity and limited production, the whole were soon relinquished, except four at Wiln.

Mr. De Jongh obtained two patents for self-acting mules, and put twelve of them in operation in a mill at Warrington, of which he was part proprietor, but with an unsuccessful result, and they were consequently given up.

Mr. Buchanan, it is reported, has several mules, partly or entirely self-acting, at work in Scotland; but the principle of their construction has not been made public.

Of Mr. Brewster's self-acting mule, nothing is known beyond the report that there are mules at work in America, of his invention, for spinning wool."

These are not mules, but a kind of self-acting jenny, used in woolen mills. Some quite novel features were presented to view; the spindles were placed in a horizontal position, some ten to fifteen inches from the floor; the creels containing the roving rose and fell in a vertical direction, &c. None of these machines, to my knowledge, are in use at the present time.

"The first approximation to a successful accomplishment of the objects in view, was an invention of a self-acting mule, by Mr. Roberts, one of the principal points of which was, the mode of governing the wind-

ing on of the yarn into the form of a cop; the entire novelty and great ingenuity of which invention was universally admitted, and proved the main step to the final accomplishment of that object which had so long been a desideratum.

For that invention a patent was obtained in 1825, and several headstocks upon the principle were made, which are still working successfully; but, from a combination of various causes, the invention was not extensively adopted.

In 1827, Mr. De Jongh obtained a third patent for a self-acting mule; upon which plan, with the addition of part of Mr. Roberts' invention, which was found to be essential, about thirty mules were made, part to spin cotton, and part woolen yarn. The greater part of these are continued at work, but, it is reported, with only a moderate degree of success.

In 1830, Mr. Roberts obtained a patent for the invention of certain improvements; and, by a combination of both his inventions, he produced a self-acting mule, which is generally admitted to have exceeded the most sanguine expectations, and which has been extensively adopted."

Such is a short sketch of the origin and progress of self-acting mules up to 1830; since that time the patent mule of Messrs. Sharp, Roberts & Co. has been extensively adopted, there being at the present time, (Dec. 1834,) in operation, in upwards of sixty mills, between 300,000 and 400,000 spindles, besides extensive orders in course of execution. It may be proper to observe, the adoption of the mechanism to

render mules self-acting, does not involve a sacrifice of the whole of the hand-mule, but merely that part of it termed the head-stock, being in value about one-fifth of the entire mule, the self-acting mechanism being contained in the head-stock, which is adapted to be applied to the other parts of a mule, as the roller-carriage. Spindles are termed the body of the mule.

In considering the advantages resulting to the proprietors of cotton mills from the use of self-acting mules, it may be stated that, although the only, or at any rate the principal benefit anticipated, was the saving of the high wages paid to the hand "spinner," and a release from the domination which he had for so long a period exercised over his employers and his fellow work people, it soon became manifest that other and very important advantages were connected with the use of the machine.

The various advantages attending the use of self-acting mule head-stocks, were enumerated in a statement submitted by Messrs. Sharp, Roberts & Co. to the proprietors of cotton mills, of the principal points in which the following is a copy:

"First, the advantages connected with spinning.

"The saving of a spinner's wages to each pair of mules, piecers only being required, one overlooker being sufficient to manage six or eight pair of mules or upwards.

"The production of a greater quantity of yarn, in the ratio of fifteen or twenty per cent. or upwards.

"The yarn possesses a more uniform degree of twist, and is not liable to be strained during the spin-

ning, or in winding-on, to form the cop; consequently fewer threads are broken in those processes, and the yarn, from having fewer piecings, is more regular.

"The cops are made firmer, of better shape, and with undeviating uniformity, and from being more regularly and firmly wound, contain from one-third to one-half more yarn than cops of equal bulk wound by hand; they are consequently less liable to injury in packing or in carriage, and the expense of packages and freight (when charged by measurement) is considerably reduced.

"From the cops being more regularly and firmly wound, combined with their superior formation, the yarn intended for warps less frequently breaks in winding or reeling, consequently there is a considerable saving of waste in those processes.

"Secondly, the advantages connected with weaving.

"The cops being more regularly and firmly wound, the yarn, when used as weft, seldom breaks in weaving; and as the cops also contain a greater quantity of weft, there are fewer bottoms. Consequently there is a very material saving of waste in the process of weaving.

"From these combined circumstances, the quality of cloth is improved, by being more free from defects, caused by the breakage of the warp or weft, as well as the selvages being more regular.

"That the advantages thus enumerated, as derivable from the use of self-acting mules have not been overrated, but in many instances have been considerably exceeded, the author, by extensive personal in-

quiry and observation, has had ample opportunity of proving, &c. &c."

This is a beautiful machine, both in its construction and movements. It removes all imperfections of the old mode of spinning, makes a better thread, and with less care and expense. Though complex, yet one endowed with mechanical skill and a matured judgment, will soon operate it to his credit.

SPOOLING MACHINES.

The office which this machine performs in the art of manufacturing, is to wind upon larger bobbins, or spools, the yarn from the smaller bobbins, or cops, and to smooth somewhat the surface of the same.

The most common form in use, consists merely of a long cylindrical shaft, containing from 10 to 16 drums, upon which rest the spools. One drum frequently drives four spools. Arches rest over these drums, to keep the spools in their proper place. In some machines, the ends to be wound off are run through two or more pieces of cloth which smooths the thread and cleans it from dirt and other impurities.

The guide-pins through which pass the ends, are made to traverse alternately from right to left the length of the spools by means of a heart motion. These drums are covered with cloth, and require to be kept perfectly true.

This is a very simple machine and requires but little power to drive it.

One of them of sixteen drums, running at a proper speed and well managed, will spool from 2,500 to 3,000 hanks per diem.

A machine for the same purpose is in use in many mills of different construction. The spindles upon which the small bobbins are placed, are horizontal, and the spools which receive the yarn are perpendicular—being in both instances the reverse of the above mentioned machine.

It performs its operations very well, requiring about the same labor and power as the common spooler.

In some mills it is common to dispense with the use of this machine,—the small bobbins being taken directly to the warper. This is an unwise and expensive practice; for the great number of bobbins in the rack will constantly be running out, making a great deal of unnecessary labor and waste.

WARPING MACHINES.

The next machine in the series is the Warper; this, like the spooler, is quite simple in its construction. A suitable rack, generally divided into two parts, contains the spools taken from the spooler to be wound on the section beam: this beam is driven by the friction of a large cylindrical drum.

Most warping machines in use in this country, are furnished with a stop-motion, by means of which the machine is instantly stopped when a thread breaks. This is rather a curious contrivance and exhibits the inventive genius of its author. It is generally ascribed to the inventor of the celebrated steam gun, Mr. Perkins.

It is quite complex in its parts, being formed of levers, dropwires, tumblers, springs, rods, &c. An explanation of its movements cannot be explicitly given without suitable plates and references. This invention is clearly illustrated in "Montgomery's Cotton Manufacture of Great Britain and America contrasted."

At first, in viewing its operations, one would imagine, that, from its complex construction, it might not answer its purpose: but this is not the case. It performs its office better and with less care than the old mode of warping.

Quite an improvement on this machine, is the introduction of balance wheels at each end of the driving drums. I tried this on a wide warping machine, and found that from 15 to 20 per cent. more yarn could be wound on in a given time, than in the usual mode; besides being more compact and even. This machine, being subject to many stoppages, it must be obvious, that a gain is here obtained.

The bearings of the section ought to be exactly weighted so that an uniform length of yarn will be run on at either end.

This point requires rigid attention as the weight

or lever may be moved by carelessness or accident. When a heavier weight is made to bear upon one end, that end will necessarily be smaller in circumference, and there is nothing makes worse work on the dressing machines: if there be but a small difference in the diameter, in winding off, it will be found that one will gain on the other so that one part of the yarn will be drawn tight and the other as loose.

This is an evil which will *be found out* by the dresser, if not attended to by the warper tender.

The circumference of the long cylinder is generally one yard; upon the end of its axis is a worm playing into a gear wheel, the object being to measure the warp. An alternate traverse motion is given the guide-bar. Close attention should be given this, to furnish even and uniform warps for the next machine in the series.

DRESSING MACHINES.

The web to be woven in the loom, is formed by this machine. Sometimes four, but generally eight of the sections made by the warping machines, are run through rollers on to the top or centre beam; one-half being at each end.

Various patterns are found in operation. Some prefer to run them at a high, others, at a low speed. Some to keep the temperature of the room quite hot, others not above 60°.

In some machines a pipe is led along under the yarn, serving to dry it quicker than the common fans. Sometimes two of these fans are only found in operation : sometimes three, with a kind of heater placed under the centre beam.

A species of upright fans similar to the windmill, have been introduced in many mills; they move with less power and cause a purer current of air to flow, than the old mode.

As in the mode of drying, so in smoothing or brushing, various ways are employed. In some machines, two cylindrical brushes, one over, and one under the warp, are made to revolve in a direction the reverse of the yarn.

In another kind, are to be found two flat brushes, one over, and the other under the yarn, moved too and fro in such a manner that they touch the yarn only in one direction.

On many machines but one of this kind of brushes is used, viz., the top one. This kind of brushing is deemed the most preferable.

The yarn passes through heavy calender rolls, running in the size, their great weight serving to expel the air contained in the filaments of the threads. An uniform thickness of paste or size ought to be used.

A new and much admired mode of driving the brushes is presented to view in many machines of our day. It consists of two eccentric wheels fixed upon the driving shaft, with grooves, fitted to which, are clasps connected with the sweeps by means of vertical arms. This is an easy, delicate motion, and

answers its purpose very well. Many other features are to be found in these machines, deserving the attention of the manager.

A machine denominated "Lillie's Sizing Machine," has been presented, which bids fair to succeed the common mode of dressing. The trough is of iron; on the bottom is cast a channel which serves to retain the steam fed by a large steam-pipe. There are openings on the upper side of this channel which are raised by the steam coming from the pipe. This steam finds its way to the yarn passing round 8, 12 or 20 rollers arranged in two rows, in order to make the warp travel up and down. After the warp has passed all these rollers, it is compressed between two larger ones by means of weighted levers. It is a powerful machine and displays the genius of its inventor.

"Mr. Lillie's sizing machines will dress a length of warps, upwards of one mile in the course of an hour. Each drying cylinder in the steam range makes 20 turns in the minute, with a diameter of 18 inches, or a circumference of $4\frac{1}{2}$ feet: but $4\frac{1}{2} \times 20 = 90$ ft. per minute, $= 5{,}400$ per hour, $= 1800$ yards. A common dressing machine does 10 pieces or cuts 60 yards each in a day; which is at the rate of 3,600 yards in a week. *

"One of these machines made by Mr. Lillie for Mr. Waterhouse, an eminent manufacturer near Man-

* This is quite too low; *most* of dressing machines in our country furnish full 60 per cent. more length than this estimate.

chester, dresses in 12 hours, 100 warps, each 370 yards long, which is no less than 37,000 in that time, being at the rate of 3,083 yards per hour, or $1\frac{3}{4}$ miles."

No machine for dressing yarn has ever been presented to be compared with this; but a limited number has, as yet, been put in operation in this country.

LOOMS.

This is the last machine employed in the process of manufacture.

Various improvements have been made upon the loom, the chief of which are, that of Horrocks' about 1813, that of Bowman's of Manchester, in 1821,—of Horrocks' again this same year,—of Roberts' in 1822,—of Buchanan's in 1823,—of Messrs. Stansfield, Briggs, Pritchard and Barraclough in 1823,—of Sadler's in 1825,—of Scholefield's in 1828,—of Graham's in 1833,—of Stone's of Rhode Island in 1834, and of Messrs. Sharp and Roberts', &c., &c. All of these are important and valuable improvements.

The crank loom of this country, is as perfect a machine, both in its construction and produce, as any in operation in Manchester, or any other place in Britain.

This is acknowledged by competent judges; and, indeed, some of the latest of American pattern looms,

with their improvements, *exceed any in use, in the world, in any respect.*

The manufacturers of this country are behind no nation in this branch, and their attention is confined in a great degree, to those preparatory branches, which they have heretofore so much neglected. There is not a doubt existing, that America is destined to outstrip the parent country in the art of cotton manufacturing. Her vast water-power, her great resources, together with her increasing supply of raw material, are proofs quite to strong of this assertion, to the minds of the English people.

Common goods, such as are generally made in this country, are actually manufactured and shipped to Manchester, cheaper than the same style of goods can there be purchased.

As yet, but a few mills are in operation in this country on fine numbers.

But the experiments thus far, conclusively demonstrate that Yankee enterprize is formidable. The goods turned out from the New York, the Salem, Portsmouth, Newburyport and other mills of the East, will bear rigid competition from any quarter, both in cost and quality.

The produce of the improved American looms is from 20 to 25 per cent. more than those constructed some 10 or 15 years since.

The average number of yards turned out per loom, per diem. on No. 16's, 36 inches wide, 56 warp threads to the inch, or 2020 in the whole width, and 56 to 60 pecks per inch, is, from 34 to 40.

Looms running on No. 28's, printing goods, with a 64 slaie, and 60 to 64 pecks per inch, will turn out on an average 5 to 6 pieces of 32 yards per week.

The general speed of the Lowell and Eastern pattern looms, is about 115 to 120 pecks per minute; some on light goods run as high as 125 or 130 pecks per minute. Beyond this speed prudence and interest teach us that it would not be advantageous to go.

COMMON SPEED OF THE VARIOUS MACHINES.

The speed of the Willow, ranges from 400 to 600 revolutions per min., with a diameter of 30 inches. Those with larger cylinders, or beaters, of course revolve with a slower speed; one $3\frac{1}{2}$ to 4 feet in diameter, runs from 350 to 450 turns per minute.

The beaters of the Lapping machine are generally regulated from 1200 to 2000 turns per minute; and 80 to 100 turns of the beater for one of the feeding rollers. It is often the case that two or more of the beaters revolve with the same speed.

The common speed of the main cylinder in Carding engines, is from 115 to 125 revolutions per min., in some engines it is common to run them as high as 150 or 160 turns per min.,—this is too high, as the great surface speed of the main drum, would prove injurious to the fibres.

The front rollers in the Drawing Frame from 1 to $1\frac{1}{8}$ inch in diameter, run from 250 to 300 revolutions per minute; with rollers of $1\frac{5}{8}$ or $1\frac{3}{4}$ inches in diameter, about 150 to 170. It is not uncommon to find drawing frames delivering at the rate of 60 to 75 feet per min. Most carders prefer using the large sized rollers.

The front rollers of the Eclipse Roving Frame, of $1\frac{1}{4}$ inch in diameter, revolve from 550 to 700 or even 750 turns per minute.

The front rollers of the Tube Frame revolve from 475 to 600 turns per minute; some are found running as high as 700 turns per minute. The speed per min. of the Bobbin and fly-frame front rollers is from 130 to 150 or even 170 turns.

The front rollers of the common Throstle Frame of $1\frac{1}{8}$ inch in diameter revolve from 55 to 65 on common numbers,—the Danforth and Ring Frames from 65 to 90 on medium numbers, and frequently as high as 100 to 115 on lower numbers.

The speed of the Mule is various, being regulated by circumstances; on mules making 3 or $3\frac{1}{2}$ stretches of 56 inches per min., the common speed of the front rollers is from 60 to 70, and that of the spindles from 3,700 to 4,500 turns per minute.

Some rollers revolve from 80 to 85 turns per min., on low number.

These are *common* speeds, but they are often varied at the option of the manager.

COMMON PRODUCE OF THE VARIOUS MACHINES.

The Eclipse Roving Frame of 10 spools will furnish with ease, 900 to 1000 spindles for the Mule or Throstle frame. Each spindle of the Bobbin and fly-frame will furnish rovings for 135 to 145 mule spindles. Each spindle of the Tube frame will furnish rovings for 400 to 450, or more, mule spindles.

Each mule spindle spinning on No. 28's will turn out 22 to 24 hanks per week of 69 hours.

Each spindle of the common Throstle frame will turn out 20 to 25 hanks of No. 32 per week.

Each spindle of the Danforth frame will turn out 32 hanks of No. 30 per week. The produce of the Ring Spinner is about the same, viz., 30 hanks per week of No. 28's to 30's.

PRODUCE OF SPINNING MACHINES.

COMMON THROSTLE.			RING SPINNER.			DANFORTH FRAME.		
Nos. of Yarn	Rev. per min. of Front Roll.	Hanks per week.	Nos. of Yarn.	Rev. per min. of Front Roll.	Hanks per week.	Nos. of Yarn.	Rev. per min. of Front Roll.	Hanks per week.
20	65	27	20	65	38	20	65	39
25	60	26	25	60	36	25	60	36¼
28	60	24	28	60	33	28	60	33½
32	55	22	32	55	31	32	55	32
36	51	21	36	50	29	36	50	30
40	50	18½	40	45	26½	40	45	28½

WATER WHEELS.

There are three kinds of water wheels,—the overshot, undershot and breast. When the water drives the wheel by its *weight*, it is demonstrated an overshot, when it drives the wheel, by its *velocity*, an undershot, and when in part both of these agencies are employed it is denominated a breast wheel.

The overshot wheel is the best mover, as from the same quantity of water there is obtained a greater power. It often happens that we cannot use this wheel, from the smallness of the fall. We then employ the breast wheel, delivering the water somewhat lower than the top of the wheel. The undershot wheel is used when the breast will not answer; the water being delivered at or below the centre. In the undershot wheel the power is to the effect as 3 to 1. Of an overshot wheel, the power is to the effect as 3 to 2,—double the effect of an undershot wheel.

To find the velocity of the water acting upon the wheel.

$\sqrt{}$(height of the fall$\times$64.38)$=$the velocity in feet per second.

1. Suppose the height of fall be 16 feet; then the $\sqrt{16\times64.38}=\sqrt{1030.08},=32.09$ feet per second.

To find the area of the section of a stream.

Divide the number of feet running in one second, by the velocity in feet per second=the section of stream in square feet.

1. Suppose there be 38 feet flowing in a second, and the velocity of stream is 5 feet per second, then

$$\begin{array}{l} 5)38 \\ \overline{7.6} = \text{the area of stream in sq. ft.} \end{array}$$

The power of the fall is found by the following rule:

The area of section where it acts upon the wheel $\times$height of fall$\times 62\frac{1}{2}$=the number of pounds the wheel can bear, acting perpendicularly at its circumference. This weight will keep the wheel equapoised: if diminished, will cause the wheel to move.

Suppose the area of section of a stream be 5 feet, and its velocity 4 feet per second, with a fall of 17 feet; then $5\times4=20$=the cubic feet running per second.

$\sqrt{(17\times64.38)}=33$=the velocity of the water at end of fall;

$\frac{20}{33}=.60,6$=the section of stream at the end in square feet. Then, $.60,6\times17\times62\frac{1}{2}=644$ pounds,=the weight the wheel will sustain in equilibrium.

The following is an extract from Banks, on Mills, p. 152.

"The effect produced by a given stream in falling through a given space, if compared with a weight, will be directly as that space; but if we measure it by the velocity communicated to the wheel, it will be as the square root of the space descended through, agreeably to the laws of falling bodies.

"*Experiment* 1. A given stream is applied to a wheel at the centre; the revolutions per minute are 38.5.

"*Experiment* 2. The same stream applied at the top, turns the same wheel 57 times in a minute.

"If, in the first experiment, the fall is called 1., in the second it will be 2; then $\sqrt{1} : \sqrt{2} :: 38.5 : 54.4$, which are in the same ratio as the square roots of the spaces fallen through, and near the observed velocity.

"In the following experiments a fly is connected with the water wheel.

"*Experiment* 2. The water is applied at the centre, the wheel revolves 13.03 times in one minute.

"*Experiment* 4. The water is applied at the vertex of the wheel, and it revolves 18.2 times per minute.

"As $13.03 : 18.2 :: \sqrt{1} : \sqrt{2}$ nearly.

"From the above we infer, that the circumferences of wheels of different sizes may move with velocities which are as the square roots of their diameters without disadvantage, compared one with another, the water in all being applied at the top of the wheel; for the velocity of falling water at the bottom or end of the fall is as the time, or as the square root of the space fallen through; for example, let the fall be 4 feet, then, as $\sqrt{16} : 1'' :: \sqrt{4} : \frac{1}{2}''$, the time of falling through 4 feet. Again, let the fall be 9 feet, then, $\sqrt{16} : 1'' :: \sqrt{9} : \frac{3}{4}''$, and so for any other space, as in the following table, where it appears that water will fall through one foot in a quarter of a second, through 4 feet in half a second, through 9 feet in three-quarters of a second, and through 16 feet in one second. And if a wheel 4 feet in diame-

ter moved as fast as the water, it could not revolve in less 1.5 seconds, neither could a wheel of 16 feet diameter revolve in less than three seconds; but though it is impossible for a wheel to move as fast as the stream which turns it, yet, if their velocities bear the same ratio to the time of the fall through their their diameters, the wheel 16 feet in diameter may move twice as fast as the wheel 4 feet in diameter.

TABLE.

Height of the fall in feet.	Time of falling in seconds.	Height of the fall in feet.	Time of falling in seconds.
1	.25	14	.935
3	.432	16	1.
5	.557	20	1.117
7	.666	24	1.22
8	.706	25	1.25
9	.75	30	1.37
10	.79	36	1.5
12	.864	40	1.58
		45	1.67

"The power water has to produce mechanical effect, is as the quantity and fall of perpendicular height. The mechanical effect of a wheel is as the quantity of water in the buckets and the velocity.

The power is to the effect as 3 : 2, that is, suppose the power to be 9000, the effect will be $=\frac{9000\times2}{3}=\frac{18000}{3}=6000$."

1. What power is a stream of water equal to, of the following dimensions, viz., 11 inches deep, 21

inches broad, velocity 80 feet in 13 seconds, and the fall 54 feet? *Ans.* 30.2 H. P.

$\frac{11\times21}{144}=1.60$ square feet;—area of stream.

13″ : 80 :: 60″ : 369.2 lineal ft. per min., velocity.

$369.2\times1.60=590.720$ cubic feet, per min.

$590.720\times62.5=36920$ pounds per min.

$36920\times54=1993680$, momentum at a fall of 54 feet.

$\frac{1993680}{44000}=45.3$ horse power.

3 : 2 :: 45.3 : 30.2, effective power.

By allowing one foot above the wheel for the admission, and one below the wheel for the escape of the water, we find that $54 - 2 = 52$ feet diameter of wheel that can be used or applied to this fall.

$52\times3.1416=163.3632$=circumf. of wheel.

$60\times6=360$ feet per min.=velocity of wheel.

$\frac{590.720}{360}=1.64\dot{1}$=area of buckets; the buckets being but half full — $1.641\times2=3.282$=the area, say this wheel is 4 feet wide—$\frac{3.282}{4}=.8205$, depth of shrouding.*

$\frac{360}{163.3632}=2.2$ revolutions per min. of wheel.

P'r of water=45.3 H. P.,	diam'r, 52 feet.
Effective p'r of water, 30.2 H. P.,	Br'th, 4 "
	Depth of shrouding, .8205.

---

* The depth of shrouding here given would be none too much in practice.

2. Required the power of a water wheel 15 feet in diameter, 12 feet wide and shrouding 15 inches deep. *Ans.* 25.5.

$15\times3.1416=47.1240$, circumference of wheel.

$12\times1\frac{1}{4}=15$ square feet, area of buckets.

$60\times4=240$, lineal feet per min.=velocity.

$240\times15=3600$ cubic feet of water with full buckets,$=1800$ when half full.

$1800\times62.5=112500$ lbs. of water per minute.

$112500\times15=1687500$, momentum falling 15 feet.

$3 : 2 :: 1687500 : \frac{1125000}{44000}=25.5$, horse power.

To find the centre of gyration of a water wheel.

Find the radius of the wheel and the weight of its arms, rim, shrouding and float boards. Multiply the weight of rim by the square of the radius, and double this product. Next, the weight of the arms, into the square of the radius, and doubled. Then the weight of the water in action, by the square of the radius. These products form a dividend. Double the sum of the weights of the rim and arms, and add the weight of the water to them, for a divisor.

1. Required the radius of the circle of gyration of a water wheel 22 feet in diameter; the weight of arms being 3 tons, shrouding 4 tons, and the water 3 tons?

$$R=4 \text{ tons}\times 11^2\times 2= \quad 968.$$
$$A=3 \text{ tons}\times 11^2\times 2= \quad 726.$$
$$W=3 \text{ tons}\times 11^2= \quad 363.$$

$$2057=\text{a dividend.}$$

then, $2\times(4+3+3)=20=$a divisor.

$$\sqrt{\frac{2057}{20}}=\sqrt{103}=10.198 \text{ nearly.}$$

"It is desirable that the millwright should possess short, easy rules, which would answer the purposes of practice rather than the conditions of mere theory. The following will be found useful, as they give the power with allowance for friction and waste of water.

1. For an undershot:—

$$\frac{\text{Height of fall}\times\text{quantity of water flowing per min.}}{5000}=$$

the number of horse power which the effect is equal to.

2. For an overshot:—

$$\text{Power of an undershot}\times 2\tfrac{1}{2}=\text{horse power.}$$

3. For a breast wheel:—

Find the power of an undershot from the top of the fall to where the water enters the bucket; then for an overshot for the rest of the fall,—the sum of these two is the power of the breast wheel.

Note.—The quantity of water flowing per minute, and the height of the fall are both taken in feet.

Ex. What power can be obtained from an undershot wheel, the fall being 25 feet, the section of the

stream being 9 feet, and the velocity of the water 18 feet per minute?

$\frac{9\times18\times25}{5000}=\frac{4050}{5000}=.81$ of a horse power, one horse power being unit.

And an overshot in the same situation would be $.81\times2.5=2.025$ horse power. And if in a breast wheel, the water enters the bucket 10 feet from the top of the fall, then we have,

$\frac{10\times8\times9}{5000}\times2\frac{1}{2}=\frac{720}{5000}\times2\frac{1}{2}=\frac{1800}{5000}=.36$ for an overshot, and for the undershot we found it before .81; hence, $.36+.81=1.17$ horse power for the breast wheel."*

STEAM ENGINE.

The remarks which follow are practical, and may be found of service to the millwright. Some of the ideas advanced, however, are not wholly original, but have been gathered from the works of eminent mechanicians.

The most common proportions of the boiler are, viz.; width 1, depth 1. 1, or 1. 2, and length 2. 5: the size or capacity being somewhat more than the power of the engine for which they are intended.

Boulton and Watt assume 25 feet of space for each

* Grier's Mechanic's Calculator, p. 213.

horse power. Some other engineers allow 5 feet of surface of water.

In Watt's common low pressure engine, steam is admitted into the cylinder whose elastic force is about that of the atmosphere, which is 15 lbs. to the square inch; but the effective pressure is generally reckoned 12 lbs. or four-fifths of this number to the square inch, allowance being made for friction and imperfect vacuums. The working pressure is generally reckoned at 10 lbs. to the circular inch, and Smeaton only makes it 7 lbs. The effective pressure is generally taken between these extremes, being equal to 9.42 lbs. to the circular inch.

Mr. Tredgold gives the following table, showing how the power of the steam, as it issues from the boiler, is distributed.

In an engine which has no condenser:

The pressure on the boiler being .		10.000
1. The force necessary for producing motion of the steam in the cylinder,	.0069	
2. By cooling in the cylinder and pipes,	.0160	
3. Friction of piston and waste,	.2000	
4. The force required to expel the steam into the atmosphere, ...	.0069	
5. The force expended in opening the valves, and friction of the parts of an engine, ...	.0622	2920
6. By the steam being cut off before the end of stroke, ...	.1000	
Amount of deductions,		3920
Effective pressure, . .		6080

In one which has a condenser:

The pressure on the boiler being .		1000
1. By the force required to produce motion of the steam into the cylinder,	.007	
2. By the cooling on the cylinder and pipes, ...	.016	
3. By the friction of the piston and loss,	.125	
4. By the force required to expel the steam through the passages, . .	.007	
5. By the force required to open and close the valves, raise the injection water, and overcome the friction of the axes, ...	.063	
6. By the steam being cut off before the end of the stroke, . . .	.100	
7. By the power required to work the air pump, ...	.050	368
Effective pressure, .		632

Different engineers form various opinions as to the power of a horse. Smeaton supposes a horse able to raise 32,000 lbs. avoirdupois 1 foot in a minute. Desaguliers makes it 27,500 lbs. Boulton and Watt 32,000 or 33,000, and the *usual* estimate is 44,000.

To find the horse power of the engine.

The effective pressure on each square inch × the area of piston in square inches × length of stroke in feet × number of strokes per minute ÷ 44000 = the number of horse power of the engine.

1. What is the power of a low pressure engine,

whose cylinder is 30 inches diameter, length of stroke 6 feet, making 16 double strokes in the minute?

Ans. 37 H. P.

NOTE.—An easy rule to find the area of the piston in square inches, is this,

$$\frac{\text{The diameter} \times \text{circumference}}{4} = \text{area.}$$

Here we have,

$$\frac{30 \times (30 \times 3.1416)}{4} = \frac{2827.44}{4} = 706.86, = \text{the}$$

area of the piston in square inches; and 12 the effective pressure, 6 the length of stroke, 16 the number of double strokes in a minute?

$$\frac{706.86 \times 12 \times 6 \times 16 \times 2}{44000} = \frac{1628605.44}{44000} = 37 \text{ horse}$$

power.

If the cylinder of a high pressure steam engine has a piston of 5 inches diameter, with a twelve inch stroke, making 32 double strokes in a minute; steam being admitted of an elastic force equivalent to 7 atmospheres on the inside of the cylinder, its effective pressure will be $7 \times 15 = 105$ lbs. to the square inch without friction; but allowing one-fifth for friction, the effective pressure will be $105-21 = 84$ lbs. to the square inch.

$$\frac{\text{here } 5 \times 3.1416 \times 5}{4} = 19.63 \text{ the area of the piston;}$$

hence, $\dfrac{19.63 \times 84 \times 1 \times 32 \times 2}{44000} = \dfrac{105530.88}{44000} = 2$ horse

power.

The pressure of the steam in a boiler is 30 lbs. per

square inch, the diameter of cylinder 12 inches, length of stroke 3 feet, and the engine making 30 double strokes per minute. Here the area of piston will be 113.097, the velocity of piston $=3\times30\times2=180$ feet per minute, and since $0.9\times30-6=21$, then,

$$\frac{0.9\times30-6\times113.097\times180}{4000}=\frac{427506.66}{4000}=10.7 \text{ horse}$$

power.

It has been stated by Mr. Thomas Tredgold, that to ascertain the velocity of the piston when the engine performs its maximum, we may employ the rule,

$$120\times\sqrt{\text{length of stroke}}=\text{velocity}.$$

If an engine has a two feet stroke, then,

$$120\times\sqrt{2}=120\times1.4142=169.704,$$

or, we may say 170, as the velocity of the piston per minute in feet; wherefore, as the engine has a single stroke of 2 feet, we have,

$$\frac{170}{4}=42\tfrac{1}{2} \text{ strokes in the minute.}$$

If an engine have a four feet stroke, then we have,

$$120\times\sqrt{4}-130\times2=240=$$

the velocity of the piston per minute, and,

$$\frac{240}{8}=30, \text{ equal the number of strokes per minute.}$$

The following table shows the length of stroke and the number of feet the piston travels in a minute, according to the number of strokes the engine makes, working at maximum.

Length of Stroke.	Number of Strokes.	Feet per Minute.
Feet. 2	43	172
" 3	32	192
" 4	25	200
" 5	21	210
" 6	19	228
" 7	17	238
" 8	15	240
" 9	14	250

To find the power to lift a weight at any velocity, $\times$ the weight in lbs. by the velocity in feet, and $\div$ by the horse power; the result is the number of horse power required.

CENTRAL FORCES.

The central forces are as the radii of the circles directly, and the squares of the times inversely; also the square of the times are as the cubes of the distances. When a body revolves in a circle by means of central forces, its actual velocity is the same as it would acquire by falling through half the radius by the constant action of the centripetal force. From these facts the following rules for central forces are derived.

$$\frac{\text{Veloc. of rev. body}^2 \times \text{weight of body}}{\text{radius of circle of revolution} \times 32} = \text{centrif. force.}$$

$$\frac{\text{velocity of revol. body}^2 \times \text{weight of body}}{\text{centrifugal force} \times 32} = \text{radius of}$$

the circle of gyration.

$$\frac{\text{centrif. force} \times 32 \times \text{rad. circle}}{\text{veloc. of revolving body}^2} = \text{weight of}$$

the revolving body.

$$\sqrt{\frac{(\text{rad. circle} \times 32 \times \text{centrifugal force})}{\text{weight}}} = \text{velocity.}$$

There will be no difficulty in applying what has been said to practice.

There are two fly wheels of the same weight, one of which is 10 feet diameter, and makes 6 revolutions in a minute; what must the diameter of the other be to revolve 3 times in a minute? Here $6^2 : 3^2 :: 10 : 2.5 =$ the diameter of the second.

What is the centrifugal force of the rim of a fly-wheel, its diameter being 12 feet, and the weight of the rim 1 ton, making 65 turns in a minute?

$$\frac{2 \times 3.1416 \times 65}{60} = 40.84 =$$

the velocity in feet per second; hence,

$$\frac{40.84^2 \times 1}{32 \times 6} = 8.687 \text{ tons,}$$

the tendency to burst.

Let us employ the centre of gyration. If the fly above mentioned is in two halves, which are joined together by bolts capable of supporting 4 tons in all their positions, the whole weight of the wheel is $1\frac{1}{2}$ tons, the circle of gyration is 5.5 feet from the axis of

motion; what must be its velocity so that its two halves may fly asunder?

The force tending to separate the two halves will be $\frac{1}{2}$ of the whole force; wherefore by the rule,

$$\frac{32 \times 4 \times 5.5 \times 2}{1.5} = 30.636 = \text{the velocity.}$$

$11 \times 3.1416 =$ circumference of circle of gyration, wherefore, 34.5576 : 30.636 :: 60 : 53.191 revolutions in a minute.—*Grier.*

To measure the quantity of Water running in a River.

Choose a part of the channel where the banks are of a determinate figure, and where they contract the channel to a uniform breadth and depth, for a distance of 30 or 40 feet, or more, (the longer the better,) and the more regular the bed of the river, the more exact the result of the experiment. Measure the breadth and average depth of the river, to find the area or section of the passage through which the water flows.

Take these measures at several different places; and if there be any difference at different places, find the area at each place, and take the average between them. Then proceed to find the velocity of the motion, by throwing into the stream any substances of the same specific gravity of water, as pieces of turnips, gooseberries, &c. which will sink to different depths in the stream, and will indicate the velocity of the current at such depths. These trials must be repeated several times, and the mean of the different results must be taken for the average velocity of the stream. The portion of the river selected for the ex-

periment should be marked by strings stretched across it, by which the observer is enabled to note more accurately the instant when the floating body passes the upper line and reaches the lower one. By a stop-watch, the number of seconds required for the stream to flow through the given length of channel, may thus be ascertained, with considerable accuracy.

Dr. Robinson gives the following table of the relative velocities of currents at the surface and bottom, and the mean between them, which will save the trouble of calculation in some of the most frequent questions of hydraulics. He takes the velocity of the surface of the middle of the stream, which is very easily measured, by any light small body, as cork, floating down, &c.

From this he calculates the retarded velocity of bottom of the stream, and finds the medium velocity by the following rule:

The velocity of the substance floating on the surface of the stream is taken *in inches per second.*

From the square root of the number of inches per second, he deducts 1, and then squares the remainder, which gives the velocity at bottom, and he finds the mean by taking the medium between these two sums. Thus; if the velocity of surface in middle be 25 in. per second, its square root is 5,—deduct 1=4. Square of this=16 inches per second, the velocity at bottom, and 25+16=41; $\frac{1}{2}$ of which=$20\frac{1}{2}$=mean velocity in feet per second. [See Table E.]

When it is desired to measure the quantity of water afforded by a stream in order to calculate the power of it with a given fall for mill purposes, or the quan-

tity of water it will afford per second for feeding canals, &c., it is usual to make the experiment during the drought of summer, when the streams are diminished in their beds. It must be evident that this is the only proper time that can be taken for calculating the *regular power* afforded by a water fall. When a stream is measured during any stage of its floods, and the standard of its power is assumed from this admeasurement, disappointment will certainly follow. Whenever the flood-waters subside, the mill wheel must remain idle for want of the calculated supply of water. During the drought of summer, a considerable river becomes so much diminished, that it may be made to pass through a sluiceway, or over the edge of a plank, whereby the quantity of water can be very exactly measured.

The rules for measuring the quantity of water thus discharged, through sluices under a given head, or over the edge of a board, or weir, with the stream open at the top, will be also given, that either of these modes of admeasurement most convenient to the engineer, may at pleasure be adopted, or all of them, to correct any error that might arise from taking one of the experiments singly. The knowledge of the velocity at the bottom of a stream is of use to an engineer to enable him to judge of the action of a stream on its bed. Every kind of soil will bear a certain velocity without changing the form of the channel.

A greater velocity would enable this water to tear it up, and a smaller velocity would permit the deposite of more movable materials from above. It appears from observation, that a velocity of 3 inches per sec-

ond, at the bottom, will just begin to work on fine clay fit for pottery, and however firm and compact it may be, it will tear it up. Yet no beds are more stable than clay, when the velocities do not exceed this; for the water soon takes away the impalpable particles of the superficial clay, leaving the particles of sand sticking by their lower half in the clay, which they now protect, making a very permanent bottom, if the stream does not bring down gravel or coarse sand which will rub off this very thin crust and allow another layer to be worn off. Six inches per second will lift fine sand; 8 inches will lift sand as coarse as linseed; 12 will sweep along fine gravel; 24 inches will roll along rounded pebbles, 1 inch in diameter, and it requires 3 feet per second, at the bottom, to sweep away shivered angular stones of the size of an egg.

Rules for calculating or measuring the quantity of water flowing through sluices or apertures, in this, as in former instances, we must multiply the area of the aperture by the velocity with which the water rushes through it.

The velocity of water flowing out of a horizontal aperture, in the bottom of a cistern, is as the square root of the height of the water above the aperture; that is, the pressure, and consequently the depth, is as the square of the velocity, and the force required to produce a velocity in a certain quantity of matter in a given time, is also as that velocity; therefore, the force must be as the *square of the velocity.*

Hence the following Table, showing the velocity in feet per minute, with which water should issue from an

aperture, at any given depth beneath the surface, from 1 inch to upwards, calculated according to the theory of falling bodies.

Depth in inches.	Velocity per min. in feet.	Depth in inches.	Velocity per min. in feet
1	138.6	15½	547.2
1½	170.1	16	555.6
2	196.2	16½	564.
2½	219.6	17	572.6
3	240.6	17½	580.8
3½	259.8	18	589.3
4	277.8	18½	597.6
4½	294.6	19	605.4
5	310.3	19½	613.2
5½	325.8	20	621.1
6	340.2	20½	628.8
6½	354.	21	636.6
7	367.4	21½	644.4
7½	380.4	22	651.6
8	392.7	22½	658.8
8½	405.	23	666.1
9	417.	23½	673.2
9½	428.4	24	680.5
10	439.3	24½	694.2
10½	450.1	25	708.
11	460.8	25½	721.8
11½	471.	26	735.
12	481.2	26½	748.2
12½	491.4	27	760.9
13	501.	27½	773.4
13½	510.6	28	786.
14	519.6	28½	798.1
14½	529.2	29	810.
15	538.3	29½	822.
		30	834.

CALCULATIONS OF POWER.

1. Required the power of a stream of water of the following dimensions, viz. 12 inches deep, 20 inches broad; velocity 75 feet in 12 seconds, and fall 40 feet. *Ans.* 23.6

$\frac{12\times20}{144}$=1.66 square feet :=area of stream.

12″ : 75::60″ : 375. lineal feet per min.=velocity.

375.×1.66=622.50 cubic feet per minute.

622.50×62.5=38906.250=pounds per minute.

38906.250×40=1556250.000 momentum at a fall of 40 feet.

$\frac{1556250.000}{44000}$=35.4 horse power.

3 : 2 :: 35.4 : 23 6 effective power.

2. Required the power of a water wheel, 16 feet diameter, 14 feet wide, and shrouding 14 inches deep. *Ans.* 25.4

16×3.1416=50.2656=circumference of wheel.

14×1$\frac{1}{6}$=16$\frac{1}{3}$ square feet, area of buckets.

60×4=240 lineal feet per min.=veloc., 240×14=3360 cubic feet water, when buckets are full; when half full, 1680 cubic feet.

1680×62.5=105000.0 pounds of water per minute.

105000.0×16=1680000=moment. falling 16 feet.

$$3 : 2 :: 1680000 : \frac{1120000}{44000} = 25.4 \text{ horse power.}$$

3. Required the power of a stream of water, 12 inches deep, 23 inches broad ; velocity 62 feet in 11 seconds, and fall 32 feet. *Ans.* 19.9

$\frac{12 \times 23}{144} = 1.96$ square feet := area of stream.

$11'' : 62 :: 60'' : 335.4$ lineal feet per min.—velocity.

$335.4 \times 1.96 = 657.384$ cubic feet per minute.

$657.384 \times 62.5 = 41086.5000$ = avoir. lbs. per minute.

$41086.5000 \times 32 = 1314768.0000$ moment. at 32 ft.

$\frac{1314768.0000}{44000} = 29.9$ horse power, then, $3 : 2 :: 29.9 :$ 19.9 effective power.

4. Required the power of an engine, the cylinder being 40 inches diameter, and stroke 5 feet.

$$\frac{40^2 \times .7854 \times 10 \times 210}{44000} = 59.9 \text{ horse power.}$$

```
Or,          40
             40
           ----
           1600
          .7854
          -----
           6400
          8000
        12800
       11200
      ---------
      1256.6400
             10
     ----------
     12566.4000
            210
    -----------
    1256640000
   251328000
44000)2638944.0000(59.9 or say 60 horse power.
   220000
   ------
    438944
    396000
   -------
     429440
     396000
     ------
      33440
```

5. What size cylinder will the above 60 horse power engine require, allowing the stroke to be 6 feet?

$$\frac{44000 \times 60 = 2640000}{228 \times 10 = \quad 2280} = 1158 \text{ inches} = \text{area of cylinder.}$$

6. What diameter is the cylinder of a 60 horse engine, common pressure?

$$\frac{\sqrt{60 \times 25^*}}{.7854} = 43.7, \text{ say } 43\tfrac{3}{4} \text{ inches diameter.}$$

* 25 inches of the area of cylinder = *one* horse power.

When the effective pressure on each inch of piston is	The area equal to one horse power will be	When the effective pressure on each inch of piston is	The area equal to one horse power will be
53 lbs.	3.7	28 lbs.	7.14
48 "	4.17	23 "	8. 7
43 "	4.65	18 "	11.11
38 "	5.26	13 "	15.46
33 "	6.06	8 "	25.

CALCULATIONS OF SPEEDS, DRAUGHTS, &c.

THESE calculations, though quite simple, are inserted for the benefit of the practical man.

The speed of the driving shafts is assumed while treating of the machines; the reader can readily substitute any other as the case may require.

To find the speed per minute of the upright driving shaft.

Multiply the number of teeth, or cants, by the speed per minute of the water wheel, and divide by the number of teeth in the wheel on the foot of the upright.

1. Suppose the number of cants to be 480, the speed per min. of wheel 3 turns, and the number of teeth in the wheel on the foot of the upright 36.

$\frac{480\times3}{36}=40$, speed per min. of upright shaft.

To find the speed per min. of the main cross shaft.

Multiply the number of teeth, or diameter of the wheel on the upright driving shaft, by its revolutions per min., and divide by the number of teeth or diameter of wheel on main cross shaft.

1. Suppose the wheel on the upright shaft to contain 76 teeth, revolving 40 turns per min., as above, and the wheel on the main cross shaft to contain 40 teeth; required the speed per min. of cross shaft.

$\frac{76\times40}{40}=76$, speed per minute of cross shaft. It will be seen that nothing is here gained.

2. Suppose the number of teeth of the wheel on the upright shaft is 80, the speed of upright 40, and the driven wheel on cross shaft 32; required the speed per min. of cross shaft.

$\frac{80\times40}{32}=100$ Or thus,

```
        80
        40
     -----
  32)3200(100, speed per min. of
     32          cross shaft.
     --
      00
```

Showing a gain of $100-40=60$.

3. Suppose the wheel of 80 teeth on this shaft, running 100 turns per min., drives another wheel on second shaft of 64 teeth; required the speed per min. of second cross shaft.

$\frac{80\times100}{64}=125$, speed of second cross shaft.

Or, suppose the shaft running 100 turns, has upon it a drum of 24 inches, driving another drum of 20 inches on second cross shaft; required the turns per min.

$$\frac{24 \times 100}{20} = 120, \text{ speed required.}$$

$$\begin{array}{lccccccc} & \text{inches.} & & \text{turns.} & & \text{inches.} & & \text{turns.} \\ \text{Or, as} & 20 & : & 100 & :: & 24 & : & 120. \end{array}$$

$$\begin{array}{r} 24 \\ \hline 20)\overline{2400} \\ \hline 120 \end{array}$$

4. Suppose the cross shaft revolves 120 turns per min., with a 24 inch drum; required the diameter of a drum to produce 160 turns per min.

$$\frac{120 \times 24}{160} = 18 \text{ inches, diameter of drum.}$$

5. Suppose the cross shaft revolves 120 times per min., with a 24 inch drum driving another shaft 200 times per min.; required the size of drum.

$$\frac{120 \times 24}{200} = 14\tfrac{2}{5} \text{ inches, diameter.}$$

Or, $200 : 24 :: 120 : 14\frac{2}{5}$.

To find the speed per minute, of Willow.

1. Suppose the driving shaft revolves 200 times per min., with a 16 inch drum driving the beater pulleys of 8 and 9 inches in diameter; required the speed of the beaters.

$$\frac{200 \text{ speed per min. of shaft} \times 16}{8} = 355.5 \text{ speed of 1st.}$$

And,

$$\frac{200 \text{ speed of shaft} \times 19}{9} = 400, \text{ speed of 2d.}$$

2. Suppose the driving shaft goes 300 rev. per min., with a 24 inch drum, driving a Bacon Willow by a pulley of $12\frac{1}{2}$ inches; required its speed.

$$\left(\frac{300\times24}{12\frac{1}{2}}\times2=\frac{14400}{25}=576,\text{ rev.}\right)$$

To find the speed per min. of the Scutching and Spreading Machine.

1. Suppose the driving shaft to revolve 225 turns per min., upon which is a 24 inch pulley driving the beater pulley of 4 inches; required the speed per min. of beater.

$$\frac{225\times24}{4}=1350,\text{ speed per min. of beater.}$$

To find the draught of this Machine.

Count the number of teeth of the wheel on the end of feeding roller shaft, call it the first leader, and also the number of teeth on the pinion which it drives, call this the first follower, and so on to the last follower on the calender roller shaft, omitting all intermediate wheels, then,

$$\frac{\text{product of leaders}\times\text{diameter of calender roller}}{\text{product of followers}\times\text{feeding roller}}=$$

draught.

1. If the leaders be 140.20 and 18, the followers 85.20 and 36, the diameter of calender roller 5, and feeding roller 2 inches; then,

$$\left(\frac{140\times20\times18\times5}{85\times20\times36\times2}\right)=\frac{252000}{122400}=2.06=\text{the draught.}$$

Again, if the leaders be 136.21 and 18, the follow-

ers 90.21 and 40, the diameter of calender roller $4\frac{1}{2}$, and feeding roller $1\frac{1}{2}$ inches ; then,

$$\left(\frac{136\times21\times18\times4\frac{1}{2}}{90\times21\times40\times1\frac{1}{2}}\right)=\frac{231336}{113400}=2.04=\text{draught.}$$

To find the speed per min. of Main Cylinder in the Carding Engine.

1. Suppose the driving shaft to revolve 120 turns per min., upon which is a 16 inch pulley driving the cylinder pulleys of 15 inches; required the speed of cylinder.

$$\frac{\text{120 turns per min.}\times\text{16 in., diam. of driving pulley}}{\text{15 inches, diameter of driven pulley}}=$$
128.

Thus,
```
      120
       16
     ----
      720
     120
    -----
15)1920(128, sp'd per min. of main cyl'r.
   15
   --
    42
    30
   ---
    120
    120
    ---
      0
```

To find the draught of this Machine.

1. Suppose the wheel on doffer shaft to be 28, and to play into another upon the side shaft of 32, and on the lower end of this side shaft a 20 that works into the wheel on feeding roller of 140, the doffer cylinder

14 inches, and feeding rollers $1\frac{1}{2}$ inches; required the draught.

$$\left(\frac{140\times14\times32}{28\times20\times1\frac{1}{2}}\right)=74.6\text{, draught.}$$

Or,

$$\begin{array}{r} 28 \\ 20 \\ \hline 560 \\ 1\frac{1}{2} \\ \hline 280 \\ 560 \\ \hline 840 \end{array} \qquad\qquad \begin{array}{r} 140 \\ 14 \\ \hline 560 \\ 140 \\ \hline 1960 \\ 32 \\ \hline 3920 \\ 5880 \\ \hline 62720 \end{array}$$

$$\begin{array}{l} 840)62720(74.6\text{=draught.} \\ \underline{5880} \\ 3920 \\ \underline{3360} \\ 5600 \\ \underline{5040} \\ 560 \end{array}$$

Where motion to the doffer and feeding rollers is communicated by a range of wheels from the main drum axle, the mode of calculating the draught is similar—taking the drivers and driven wheels separately, as above.

When wheels of the same size or number of teeth occur both as leaders and followers, they are omitted in calculation.

To find the speed per min. of the Doffing Cylinder.

1. On the railway shaft revolving 8 times per min. is a pulley 9 inches in diameter, leading to another of 3 inches in diameter; on the side of this smaller pulley is a stud wheel of 16 teeth, working into the doffer wheel of 40 teeth; required the speed per minute of doffer.

Multiply the speed of railway shaft by the diameter of the pulley thereon, then by the number of teeth in the stud wheel; then multiply the doffer wheel by the small receiving pulley, and divide the former by the latter; thus,

$$\left(\frac{8\times6\times16}{40\times3}=\frac{768}{120}\right)=6.4=\text{speed of doffer.}$$

Or, when the doffer is driven by a range of wheels from the main drum axle: multiply the number of teeth in the pinion on the end of main drum axle, and that of the small stud wheel (driving the doffer,) together, then by speed per min. of main drum;— this will form a dividend. Then multiply the doffer, and large stud wheel together for a divisor.

2. Suppose the pinion on main drum axle to contain 18 teeth, the small stud wheel 46, and speed of main drum 120 turns per min., the doffer wheel 138, and the large stud wheel the same; required the doffer speed per min.

$$\left(\frac{18\times46\times120}{138\times138}\right)=5.21\text{ rev. per min. of doffer.}$$

Or,

```
 138            18
 138            46
-----          ----
 1104          108
 414           72
138            ----
-----          828
19044           120
               ----
      19044)99360(5.21 rev.
            95220
            -----
            41400
            38088
            -----
             33120
             19044
             -----
             14076
```

To find the speed per min. of the Feeding Rollers.

1. The wheel on the end of doffer shaft is 28, revolving 6.4 times per min., and drives another on upper end of the side shaft of 32 teeth; on the lower end of this shaft is a 20 working into a 140 on the end of feeding rollers; required the speed per min. of feeding rollers.

Multiply speed of doffer 6.4 by its driving wheel, then by the 20 on the lower end of side shaft for a dividend; then×the 32 and 140 for a divisor; thus,

$$\left(\frac{6.4\times28\times20}{32\times140}\right)=0.80 \text{ rev. per min. of feed rollers.}$$

Or, as

teeth.		turns.		teeth.		turns.		teeth.		turns.		teeth.		turns.
32	:	6.4	::	28	:	5.6	then, as	140	:	5.6	::	20	:	.80

Or, when the rollers are driven by a range of wheels from the main drum; multiply the number of teeth in the driving wheels together, and this by the turns

of main drum per min.: then multiply the driven wheels together for a divisor.

2. Suppose the drivers to be 18, 16 and 16, and speed per min, of main drum 115 turns, the driven wheels 32, 140 and 140; required the speed per min. of feeding rollers?

Thus,

$$\left(\frac{18\times16\times16\times115}{32\times140\times140}\right)=0.84.$$

Or,

Wheel on main axle	18	First driven wheel,	32
Second driver,	16	Second do. do.	140
Third driver,	16	Third do. do.	140

		Teeth in 1st wheel,	32
Rev. per min. of main drum,	115	do. 2d do.	140
Wheel on main drum axle,	18		1280
	920		32
	115		4480
	2070	do. 3d do.	140
Second driving wheel,	16		179200
	33120		4480
	16		627200

```
627200)529920(0.84+rev. per minute.
       5017600
       2816000
       2508800
        307200
```

To find the revolutions of the Main Cylinder for one of the Doffing Cylinder.

1. On the main drum axle, is a pinion of 18 teeth, driving a large stud wheel of 140 teeth, upon the side of this last wheel is a 40 driving the doffer wheel of 140 teeth; required the proportion.

Multiply the 18 and 40 together for a divisor, and the 140 stud, and 140 doffer wheel for a dividend.

First driver, .	18	First driven, .	140
Second do. .	40	Second do. .	140
	720		

720)19600(27.2 pro.
1440
5200
5040
1600
1440
160

The revolutions of the main drum for one of the doffer, are generally from 14 to 34, varying according to the quality of stock, and work required.

To find the revolutions of the Main Cylinder for one of the Feeding Rollers.

Begin at the pinion on the main drum axle and trace out all the driving and driven wheels to the feeding rollers. Multiply the former together for a divisor, and the latter for a dividend.

1. Suppose the drivers are 18, 16 and 16; and the driven wheels 28, 140 and 140; required the proportion.

First driver, .	18		
Second do. .	16		
	288	First driven, .	28
Third do. .	16	Second do. .	140
	1728		3920
	288	Third do. .	140
	4608		

4608)548800(119.09 pro.
4608
8800
4608
41920
41472
44800
41472
3328

Most cylinders revolve considerably slower for one turn of the roll. This is only intended to show the mode of ascertaining the relative speed.

To find the length of the card-sliver, or end delivered per min. from the Carding Engine.

Multiply the circumference of the doffer cylinder, by the number of revolutions it makes per min.

Or, where there is a drawing head or calender roller through which the end passes; trace the drivers from the main drum axle to the calender rollers, and multiply their product by the revolutions of the main cylinder; multiply the driven wheels together and divide the result of the former operation.

1. Suppose the drivers to be 18 and 44, and the driven wheels 140 and 20, the speed per min. of cylinder 120 turns; required the length delivered per min.

Speed of main drnm,		
	120	140
	18	20
	960	2800=divisor.
	120	
	2160	
	44	
	8640	
	8640	

2800)95040(33.94 rev. per min. of cal'r rollers.
8400
11040
8400
26400
25200
12000
11200
800

This operation gives the revolutions per min. of the calender rollers, which multiplied by the circumference of the delivering ball shows the length of the sliver. Allow the diameter of the ball to be $2\frac{3}{4}$ in.; what is the length in inches produced per min.?

$2\frac{3}{4}$ inches$\times$3.1416 the circumference of one inch,$\times$ 33.94 the rev. per min. of calender rollers=293.221= length produced per min.

To find in what proportion a card should furnish the spinning with sufficient preparation in changing from one number to another.

1. Suppose a pair of mules (or any number of spindles) are spinning 75's weft, with 80 turns in a certain length of lap, weighing $8\frac{1}{2}$ lbs., and it is required to change the yarn to 85's warp with 100 turns. What is the weight of lap of the same length?

Now, 85's twist requires a lighter lap than 75's weft, and 100 turns require a lighter lap than 80 turns: then we multiply the 100 by 85's for a divisor, and the 80 turns by 75's, then by $8\frac{1}{2}$ pounds, the weight of the lap, for a dividend.

thus: $100 \times 85 = 8500 =$ divisor,

and $80 \times 75 = 6000 \times 8\frac{1}{2} = 51000 =$ dividend $\div 8500 = 6$ pounds=weight of lap.

To find the speed of the Drawing Frame Cylinder.

1. Suppose the main shaft revolves 95 times per minute, with a 16 inch pulley driving a 14 on the cross shaft, which drives the cylinder pulley of 10 inches: required the speed per minute of shaft.

$\times 95 \times 16 \div 14 = 108 =$ the speed per min. of cross-shaft

$\times 14 \div 10 = 151.2 =$ speed per min. of cylinder shaft.

Or, $\times$ the driving drums 16 and 14×95 speed per min. of main shaft and $\div 10 \times 14$ the driven pulleys,= =speed per min. of cylinder shaft.

To find the speed per minute of the Front Roller in the Drawing Frame.

1. Suppose the cross shaft revolves 108 turns per min. with a 14 inch drum driving the cylinder shaft by a pulley of 10 inches, which drives the front rollers by a pulley of 7 inches: required the front roller speed.

$\overline{\times 108 \times 14 \div 10} = 152$=speed of cylinder shaft, $\overline{\times 10 \div 7}$ $=217$=front roller speed per minute.

Or, where there is a stud gear on side belt pulleys, working into a wheel or front roller, thus:

2. Suppose the stud gear wheel to contain 74 teeth, the front roller wheel 56, and the cylinder and bell pulleys 8 and 7 inches.

Multiply 152, speed per min. of cylinder$\times 8 = 1216 \div 7 = 174$,=speed of bell pulleys$\times 74 = 12876 \div 56 = 229.9$ say 230 speed of front rollers, per min.

Or, $\overline{(152 \times 74 \times 8 \div 56 \times 7)} = 229.9$.

To find the draught of the Drawing Frame.

Begin at the wheel on the back roller of the back beam, and trace out all the leaders and followers to the wheel on the delivering shaft; multiply the number of teeth in all the leaders together, and the product by the diameter of the delivering roller on the delivering shaft; then in the same way, multiply the number of teeth in all the followers together, and the product by the diameter of the back roller.

The former divided by the latter is the draught of the drawing frame.

1. Suppose the wheel on the back roller of the back beam is 40,* the wheel on front roller of back beam 16,† the wheel on front roller of back beam 40,* the wheel on back roller of front beam 38,† the wheel on back roller of front beam 38,* the wheel on the front roller of front beam 16,† the wheel on front roller of front beam 36,* the wheel on delivering roller 74† teeth, the diameter of delivering roller 2 inches,* and that of the back roller 1 inch,† in diam.; required the draught.

*Leaders.			†Followers.		
Back roller, back beam,	40	teeth.	Front roller, back beam,	16	teeth.
Front " "	40	"	Back " front "	38§	"
Back " front beam,	38§	"	Front " " "	16	"
Front " "	36	"	Wheel on deliv. shaft,	74	"
Diam. of delivering ball,	2	inches.	Diam. of back roller,	1	inch.

40	16
40	16
1600	96
36	16
9600	256
4800	74
57600	1024
2	1792
18944)115200(6.08 Draught of the Drawing Frame.	18944
113664	
153600	
151552	
2048	

§ These occur both as driver and driven, and for this reason are omitted in the operation.

To find the revolutions per minute, of the Back Roller in the Drawing Frame.

Begin at the pinion on the front roller of front beam and trace out all the leaders and followers to the wheel on the back roller of the back beam; multiply the leaders together and their sum by the rev. per min. of the front roller for a dividend: then multiply the followers together for a divisor.

1. Suppose the wheel on front roller of front beam to contain 17 teeth, the wheel on back roller of front beam 40, the wheel on back roller of front beam 40, the wheel on front roller of back beam 42, the wheel on front roller of back beam 17, and the wheel on back roller of back beam 44 teeth; the revolutions per minute of front roller 217: required the revolutions per minute of back roller.

Leaders.		*Followers.*	
Pinion on the front roller of front beam, . .	17 teeth.	Wheel on back roller of front beam, . .	40 teeth.
Wheel on back rol. of do.	40 " *	Wheel on front roller of back beam, . .	42 teeth.
Pinion on front roller of back beam, . .	17 teeth.	Wheel on back rol. of do.	44 "
Revolutions of front rollers per minute, . . .	217	Wheel on front roller of back beam, . . .	42
Pinion on frt. rol. frt. beam,	17	Wheel on back rol. of do.	44
	1519		168
	217		168
	3689		1848
Pinion on frt. rol. back do.	17		
	25823		
	3689		

```
1848)62713(33.93 revolutions of back rollers
      5544                per minute.
      ----
       7273
       5544
       -----
       17290
       16632
       -----
         6580
         5544
         ----
         1086
```

To find how many Carding Engines are necessary to supply the Drawing Frame.

Multiply the inches taken in by the back rollers per min. by the number of slivers or ends put up, and divide the product by the inches delivered by each card per minute.

Thus: rev. per min. of back rollers **33.93×3.1416**, the circumference of roll. ×12=no. of ends put up, =1291.13=a dividend, this÷293=the length produced

---

* Driver and Driven.

per min. of card, =4.4 or about $4\frac{1}{2}$ cards to the drawing frame. This number, however, in practice would not be quite sufficient, owing to stoppages, &c.

To find the size of end after going through a Drawing Frame.

Multiply the doublings at each box one into another for a divisor, and the draught of each box one into another for a dividend, the product will be the size of hank.

1. Suppose the card-sliver to be $\frac{1}{4}$th of a hank, and goes through 3 boxes of drawing, and puts up 6 ends at each box, and the draught of the boxes to be 4.75. Required the size, or count.

1st box 6 ends×4=24	4.75 or $4\frac{3}{4}$
6	4
144	19
	6 ends.
	114
114	144 3d box.
576	456
144	456
144	114
16416	16416(1 or $\frac{1}{4}$ of a hank.

Consequently, nothing is here gained but doubling.

To find the number or counts when the last box drawing has gone through a coarse slubbing machine.

1. Suppose the last box drawing by $\frac{1}{4}$ of a hank as above, and go up single at the slubbing machine, with a 21 pinion wheel on front roller, a 56 top carrier, a 42 back roller wheel, and a 28 change wheel: Required the counts.

Multiply the 21 pinion wheel by the 28 change wheel for a divisor; then multiply the 56 top carrier by the 42 back roller wheel for a dividend.

Thus:	21 Pinion Wheel.	56	Top Carrier.
	28 Change "	43	Back roll. wheel.
	168	112	
	42	224	
	588	2352(4 dra'hts or 1 hank.	
		2352	

To find the change wheel when the last box drawing has gone through a slubbing machine.

1. Suppose the last box of drawing be as above, $\frac{1}{4}$ of a hank, and goes up single to the slubbing machine with a 21 pinion wheel on front roller, and the top carrier 56, and the back roller wheel 42 teeth, and the draught or extension of sliver 4: required the change wheel.

Multiply the 21 on front roller by the draught 4 for a divisor, and then the top carrier 56 by the back roller wheel 42 for a dividend.

Thus: 21 Pinion.	56 Top carrier.
4 Draught.	42 Back Roller wheel.
84	112
	224

84)2352(28=change wheel.
168
672
672

To find the counts after going through a roving billy.

1. Suppose a bobbin of 1 hank be drawn into a roving and put up two ends, with a 20 pinion wheel and an 80 top carrier, and a 60 back roller wheel and a 30 change wheel: required the counts. Multiply 20 pinion wheel × 2 ends put up × 30 change wheel for a divisor: then × the 80 top carrier by the 60 back roller wheel for a dividend.

Thus: 20×2×30=1200, and 80×60=4800÷1200=4=no. hanks.

To find the change or altering wheel.

1. Suppose a bobbin of 1 hank be drawn into 4, and go up double to the billy, or stretcher, with a 20 pinion and an 80 top carrier, and a 60 back roller wheel: required the change wheel?

Multiply 20 pinion × 2 ends put up, = 40×4 hank roving,=160 = a divisor; and × 80 top carrier × 60 back roller wheel, = 4300÷160 = 30 = the change wheel required.

To find the revolutions per minute of front rollers in fly frame.

Multiply the number of teeth in the pinion wheel on the frame shaft by the revolutions per minute of the shaft, and divide this product by the number of teeth in wheel on front roller.

1. Suppose the pinion on frame shaft to contain 30 teeth, the revolutions per minute of frame shaft 210, and the wheel on front roller 54 teeth: required the revolutions per minute of front rollers.

```
No. teeth in pinion wheel,      30
Rev. pr min. of frame shft.    210
                               ———
No. t'th in fr. rol. wh'l. 54)6300(116.66 rev. per min.
                              54
                              ——
                               90
                               54
                               ——
                               360
                               324
                               ———
                                360
                                324
                                ———
                                 360
                                 324
                                 ———
                                  36
```

To find the revolutions of the spindle per minute.

Multiply the speed per minute of frame shaft by the diameter of the twist pulley, and divide the product by the diameter of the spindle wharve, or pulley.

1. Suppose the speed per minute of frame shaft is 210, the diameter of twist pulley 9, and that of the

wharve, or pulley, 3 inches: required the speed per minute of spindle.

Rev. per min. of frame shaft,	210
Diameter of twist pulley,	9
Diameter of spindle pulley,	3)1890
	630 speed of spindle.

It is obvious that when gears are employed, the same rule is to be observed,—substituting the number of teeth, in the room of inches in diameter. Most of this kind of machines are now driven by wheel-work.

To find the twists per inch on the roving in the Fly Frame.

Multiply the circumference of the front roller by its revolutions per minute; this will give the length in inches produced per minute: then divide the revolutions per minute of the spindle by this product.

1. Suppose the turns per minute of front roller to be 116.66, the circumference 3.80 inches, and the revolutions per minute of spindle, 630: required the twist per inch.

Rev. of front roll. per min.	116.66
Circum. of front roller,	3.80
	933280
	34998
	443.3080=a divisor.

```
443.31)630    (1.42 twists per inch.
443.31
186690
177324
 93660
 88662
  4998
```

To find the speed per minute of the rim, or fly, on the mule jenny.

Multiply the diameters of the driving drums and pulleys together, and their product by the speed per minute of driving shaft for a dividend: then multiply the diameters of the driven drums and pulleys for a divisor.

1. Suppose the driving drums are 18 and 16, the speed per minute of driving shaft 100, and the driven drums 16 and 14 inches: required the speed per min. of the fly.

Speed of driving shaft,	100	First driven,	16*
First driver,	18	Second do.	14
	1800		224=divisor.
Second driver,	16*		

224)28800(128.5 speed per min. of fly.
224
640
448
1920
1792
1280
1120
1600
1568
32

* These wheels may be omitted and the same result is found.

To find the revolutions per minute of the front rollers in the mule jenny.

Multiply the driving wheels together, and their product by the speed per minute of the rim, or fly, for a dividend; then multiply the driver wheels together for a divisor.

1. Suppose the driving wheels to be 84 and 40, the speed of rim 128, and the driven wheels 80 and 72 teeth: required the turns per minute.

First driver on axle of rim, 84 teeth.	First driven on upper end of diag. shaft, 80 te'h.
Second do. on lower end of diagonal shaft, 40 "	Second do. on frt. rol. 72 "
3360	160
Rev. per min. of rim, 128	560
26880	5760
6720	
3360	

5760)430080(74.66 front roller speed.
40320
26880
23040
38400
34560
38400
34560
3840

To find the revolutions per minute of the spindles in the mule jenny.

Multiply the drawing wheels and pulleys from the rim to drum band pulley, and their product by rev. per min. of rim for a dividend; then in the same way multiply all the driven wheels and pulleys for a divisor.

1. Suppose the diameter of rim is 38 inches, the large twist pulley 16 inches, the small twist pulley 10 inches, the rim of drum band $9\frac{1}{2}$ inches, the drum band pulley 10 inches, the wharve on spindle $\frac{3}{4}$ths of an inch in diameter, and the rev. per min. of rim 128: required rev. per min. of spindles.

Thus: $38\times10\times10\times128=486400$=dividend: and $16\times9\frac{1}{2}\times\frac{3}{4}=114$=divisor: then $486400\div114=4267$ nearly=speed of spindles.

To find the twists per inch on yarn of mule jenny.

Multiply the turns per minute of front roller by its circumference, and divide the turns per minute of the spindles by this product.

1. Suppose the turns per minute of front roller are 74.66, the circumference 3.80 and the rev. per min. of spindle 4267: required the twists per inch.

```
Rev. per min. of fr't rol., 74.66
Circumference of     "       3.80
                           ------
                           597280
                          22398
                          -------
                  283.7080)4267. sp. pr m. of s.(15.04 ts. pr in.
                           283.71
                           ------
                           142990
                           141855
                           ------
                            113500
                            113484
                            ------
                                16
```

To find the draught of the mule jenny.

Multiply the change or altering wheel by the pinion on front roller, and this by diam. of back roller for a divisor; then multiply the top carrier by the back

roller wheel, and this by diam. of front roller for a dividend.

1. Suppose the pinion on coupling shaft is 21, the top carrier 116, change wheel 36, back roller wheel 60, the diam. of back roller $\frac{8}{8}$ of an inch, and the front roller $\frac{9}{8}$: required the draught.

Change wheel, 36 teeth.	Top carrier wheel, 116 teeth.
Pinion " 21 "	Back roller " 60 "
36	6960
72	Diam. of front rol. $\frac{9}{8}$
756	6048)62640(10.35=draught.
Diam. back rol. $\frac{8}{8}$	6048
6048	21600
	18144
	34560
	30240
	4320

To find the counts after going through the mule jenny.

Multiply the pinion wheel by the change wheel and this product by the length of yarn turned out from the front roller for a divisor; then multiply the top carrier by the back roller wheel, then by the length of stretch put up, and this by the number of hanks roving for a dividend.

1. Suppose a roving of 4 hanks be drawn into yarn with a 21 pinion wheel, a 116 top carrier, a 60 back roller wheel, a 36 change wheel, the length of the stretch put up 58 inches, and the length of yarn turned out from the rollers 50 inches: required the number of hanks.

Pinion wheel,	21 teeth.
Change do.	36 do.
	126
	63
	756
Len'h tr'd out,	50 in.
	37800

Top carrier, . .	116 teeth.
Back rol. wheel, . .	60 do.
	6960
Length of stretch,	58 in.
	55680
	34800
	403680
No. of roving, .	4

37800)1614720(42.71. *Ans.*
151200

102720
75600

271200
264600

66000
37800

28200

To find the number of hanks of roving from the number of hanks of the mule yarn.

Multiply the number of hanks of yarn by the gain of carriage, and divide this by the number of inches put up; this gives the alteration of hanks by the gaining of the carriage; subtract this number from the number of hanks mule yarn, and multiply the product by the pinion and change wheels for a dividend; then multiply the top carrier by the back roller wheel for a divisor.

1. Suppose the number of yarn to be 42.71, the gaining of carriage 8 inches, the number of inches put up 58, the pinion wheel 21, the change wheel 36 teeth, the top carrier 116, and back roller wheel 60 teeth: required the hanks roving.

Top carrier,	116 teeth.	No. of yarn, . .	42.71
Back Roller,	60 do.	Gain of Carriage, . .	8 in.
	6960	Inches put up,	58)341.68(5.89+

```
   42.71              290
    5.89              ---
   -----              516
   36.82              464
      21              ---
   -----              528
    3682              522
   7364               ---
   ------               6
  773.22
      36
  ------
  463932
 231966
 -------
6960)27835.92(4 hanks roving.
     27840
```

To find a wheel to put on the bottom of the diagonal shaft, to make the front rollers turn out a certain length, or number of inches in a certain number of revolutions.

1. Suppose the rollers turn out 54 inches in 57 turns, with a 56 wheel on rim shaft, a 54 on top of diagonal shaft, a 100 on coupling shaft, and the circumference of front roller 3.14 inches; required the wheel on bottom of diagonal shaft.

Multiply the wheel on the rim shaft by the turns, and the circumference of the front roller, for a divisor; then multiply the wheel on top of diagonal shaft, by the inches turned out, then by the wheel on coupling shaft for a dividend.

Wheel on rim shaft, .	56 teeth.
No. of turns,	57
	392
	280
	3192
Cir. frt. rol.	3.14
	12768
	3192
	9576
	10022.88

Wheel on top diagonal shaft, . . .	54 teeth.
Inches turned out, . .	54
	216
	270
	2916
Wheel on coupling shaft,	100
	10022.88)291600.00(29+
	2004576
	9114240
	9020592
	93648

It will be seen that the decimal of the circumference of front roll, has made the true result vary somewhat. The proper wheel is 30 teeth.

To find the change wheel in altering from one number to another, without changing the roving.

1. Suppose the mule jenny, (or throstle frame,) be spinning 30 hanks in the pound, with a 28 change wheel, and it is required to spin 40 hanks in the pound; required the change wheel.

Now, a little reflection will convince us that the latter number will require a *less* change wheel, than the former; therefore, we multiply the 30 hanks and 28 change wheel together, for a dividend, and divide the result by the number of hanks required. Thus, $30\times28\div40=21$=change wh'l. Or, as 40 : 28 :: 30 : 21.

To find the change wheel in altering from one number to another when the change wheel and roving require to be altered.

1. Suppose you are spinning 30's with a 4 hank roving, and a 26 change wheel, and it is required to change to 36's with 5 hank roving: required the change wheel.

Multiply the 36's by the 4 hank roving for a divisor; then multiply the 30's by the 5 hank roving, and this product by the 26 change wheel for a dividend.

36 and 4 ‖
30 and 5 and 26. ‖

```
                 30
                  5
                ---
                150
                 26
               ----
                900
               300
               ----
4×36=144)3900(27. Ans.
               288
               ----
               1020
               1008
               ----
                 12
```

To find the diameter of the mendoza pulley to move the carriage uniformly with the surface speed, or delivery of front roller.

Multiply the diameter of the front roller by the teeth in the mendoza wheel, and divide this result by the teeth in pinion on the front roller that drives the mendoza wheel. Subtract from this product the

diameter of the mendoza band, and the result is the diameter of a pulley that will move the carriage out as fast as the yarn is delivered by the front rollers.

1. Suppose the number of teeth of mendoza wheel to be 118, the diameter of front roller $1\frac{1}{8}$ inches, the pinion on front roller 21 teeth, and the diameter of band $\frac{5}{8}$ of an inch: required the diameter of pulley.

thus: $\overline{\left(\frac{118\times1\frac{1}{8}}{21}-\frac{5}{8}\right)}=5.695=$the diam. of pulley to move the carriage as fast as the delivery of yarn.

2. Suppose the length of stretch is 56 inches, the gain upon the same 6 inches; required the pulley to move the carriage with a gain of 6 inches on the stretch.

thus: 56×5.695 the diam. of pulley to move the carriage as fast as the delivery of yarn$=\overline{318.920\div56-6}$, gain of carriage$=6.374$, or say $6\frac{3}{8}$ inches diameter of pulley required.

3. Suppose the length of stretch is 58 inches with a gain of $7\frac{1}{2}$ inches; required the pulley.

thus: $\left(\frac{58\times5.695}{58-7\frac{1}{2}}\right)=6.54$ in. diameter.

To find a wheel to put on the middle roller, for the middle roller to draw from the back roller 6 *into* 7, *and* 6 *into* 8.

1. Suppose the diam. of the back roller is $\frac{8}{8}$ and the diam. of the middle roller is $\frac{7}{8}$ of an inch, and back roller wheel 24 teeth; required the middle roller wheel.

$(24\times7=168\div8=21\times6=126\div7)=18=$wheel required.

2. Suppose the back roller wheel is 32, the diameters of the back and middle rollers $\frac{8}{8}$ and $\frac{7}{8}$ inch, and you wish to draw the middle in the proportion of 6 to 8. thus: $(32\times7=224\div8=28\times6=168\div8)=21$=wheel requ'd.

To find the number of stretches upon a cop.

1. Suppose a cop runs 10 leas with 80 turns of the reel in one lea, and 54 inches in one turn, and the number of inches the mule puts up is 58; required the stretches.

10 leas $\times$ 80 turns $\times$ 54 inches and $\div$ 58 inches put up=the number of stretches.

thus: $10\times80=800\times54=432000\div58=744\frac{24}{29}$ stretches.

To find the draught of the Spinning Frame.

1. Suppose the drivers are 26 and 30, the driven wheels 116 and 56, the back roll $\frac{7}{8}$, and the front roll $\frac{9}{8}$ of an inch in diameter: required the draught.

1st driver,	26 teeth.	1st driven wheel	116
2d do.	30	2d do. do.	56
	780		696
diam. back rol.,	$\frac{7}{8}$		580
	5460		6496
		diam. frt. rol.,	$\frac{9}{8}$

$$
\begin{array}{r}
5460)58464(10.52\\
5460\\
\hline
28640\\
27300\\
\hline
13400\\
10920\\
\hline
2480
\end{array}
$$

The twist, produce, &c. of this machine, are found in the same way as the mule, and one acquainted with the preceding operations will readily perform others of a similar nature.

To find in what proportion to put twist in yarn per inch, in changing from one number to another.

A good rule is to add $2\frac{1}{2}$ revolutions of the spindle for every 10 hanks. For instance: suppose you are spinning 30's twist with 20 revolutions of the spindle per inch, and it is required to change to 45 twist; required the revolutions of spindle per inch.

Now, 45's—30's=15 hanks finer than present spinning$\times 2\frac{1}{2}=3.75$ and $3.75+20=23.75$ or $23\frac{3}{4}$ twist per inch of number 45 twist.

Suppose you are spinning 40's weft with $16\frac{1}{2}$ rev. of the spindle per inch, and it is required to change to 50's weft; required the rev. of spindle per inch. Thus: 50—40=10 hanks finer than you are spinning, $\times 2\frac{1}{2}=2.5+16.5=19$ twist per inch of number 50.

The number of twists given to the yarn varies with the fineness of the fibres and yarn, and whether or not it be required for warp or weft. A good *practical* rule for finding the twists per inch of any number of yarn, is the following, viz.: $\surd$ number of yarn $\times$ for the twists per inch of warp, and $\surd$number of yarn 3.75$\times$3.25 for weft yarn.

Thus: for number 25 warp yarn, we have $\surd 25=5\times 3.75=18.75$ twists per inch: for 36 weft, $\surd 36=6\times 3.25=19.50$ twists per inch of 36 weft.

Computation of the length and fineness of cotton yarn.

Yards.		Threads.						
$1\frac{1}{2}$	=	1		Skeins.				
120	=	80	=	1		Hanks.		
840	=	560	=	7	=	1		Spindle.
15120	=	10080	=	126	=	18	=	1

Thus: number 20 yarn contains 20 hanks, or 20× 840 yards =16,800 yards in one pound: number 35 contains 35×840 yards=29,400 yards in one pound: and number 11 yarn contains 11×840 yards =9,240 yards in one pound, &c.

When we wish to determine the fineness of yarn, we take a few cops or bobbins and reel them, and find their weight, then say as the weight of cops or bobbins : 16, the number oz. in the pound :: 18, the number of hanks in spindle : weight or number of the yarn.

Suppose the weight of spindle to be 5 ounces, then, 5 : 16 :: 18 : $57\frac{3}{5}$, number of yarn.

Again: suppose the weight of spindle to be 8 ounces, then, 8 : 16 :: 18 : 36, number of yarn.

$$\text{Or, } \frac{288}{\text{weight of spindles in oz.}} = \text{No. of yarn.}$$

$$\text{and, } \frac{288}{\text{no. of yarn}} = \text{weight of spindle in ounces.}$$

Computation of the length and fineness of woolen yarn.

Yards.		Knots.				
80	=	1		Skeins.		
320	=	4	=	1		Run.
1600	=	20	=	5	=	1

To find the speed per minute of the power loom.

Multiply the diameter of drum or pulley on driving shaft by its revolutions per minute, and divide the product by the diameter of the pullies on loom shaft.

1. Suppose the diameter of drum on driving shaft is 16 inches, the revolutions per minute of shaft 100, and the loom belt pulleys 14 inches; required the speed per minute of loom.

thus: $16 \times 100 = 1600 \div 14 = 114\frac{4}{14}$.

Or, as $\underset{\text{inch.}}{14} : \underset{\text{inch.}}{16} :: \underset{\text{rev.}}{100} : \underset{\text{rev.}}{114\frac{4}{14}}$:

2. And, 100 revolutions per minute of driving shaft$\times$16 inches driving pulley$\div$14 inches loom pulleys$=125\frac{5}{7}$ revolutions of loom shaft.

3. Suppose the wheel on end of loom shaft to be 56, driving the cam shaft by a wheel of 112: required the turns of cam shaft.

($\times$114, rev. of loom shaft $\times 56 = 6384 \div 112) = 57$ turns of cam shaft. Or, $(114 \div (\overline{112 \div 56}) = 57$.

Suppose the loom makes 120 pecks per min.$=$a single peck in half a second. Hence the loom shaft makes a turn in half a second, or two turns in one second; and the cam shaft makes a turn in one second; now this cam shaft must make $\frac{1}{12}$ of a revolution to open the shades sufficiently: this movement will require $\frac{1}{12}$ of a second: it remains open $\frac{1}{3}$ or $\frac{4}{12}$ of a second and requires $\frac{1}{12}$ of a second to return: so we perceive that $\frac{1}{2}$ or $\frac{6}{12}$ of a second elapse between the time when the warp begins to open, and the time of closing, leaving $\frac{1}{3}$ or $\frac{4}{12}$ of a second, as the time it remains open. The shuttle is

thrown at the time when the tappet-pin or roller strikes the treadle underneath, &c., &c.

To find the weight of a Warp.

Multiply the length by number of beers, then by number of ends in a beer=the number of yards; then divide the number of yards by 840=number of hanks; then÷by the number of yarn and it will give the number of pounds required.

1. Suppose a warp to contain 18 cuts of 30 yards each, with 35 beers, and 60 ends in each beer and the number of yarn 28's twist; required the weight of warp.

Ans. 48 lbs. 3 oz. 12 drs.

```
18 cuts×30 yds.=540
   No. of beers     35
                  ----
                  2700
                 1620
                 -----
                 18900
No. of ends in beer,    60                 h'ks. lbs. oz. drs.
                 -------
No yds. in hank 840)1134000(28)1350(48—3—12.
                 840         112
                 ---         ---
                 2940         230
                 2520         224
                 ----         ---
                  4200          6
                  4200         16
                  ----         --
                     0         96(3
                               84
                               --
                               12
```

To find the weight of Weft to fill this Warp.

Multiply the length by the breadth, then by number of pecks per inch=the number of yards; then divide this by 840=the number of hanks; then divide by number of yarn=the weight.

Suppose the breadth to be 28 inches, the number of pecks per inch 60, and the number of weft or filling 30; required the weight?

Ans. 36 lbs.

Length of warp,	540
Breadth do.	28
	4320
	1080
	15120
No. pecks per inch,	60

h'ks.
840)907200(30)1080(36 pounds.
840   90
6720   180
6720   180
0   0

2. Suppose the length of a warp be 500 yards, the breadth 36 inches, the number of pecks per inch 56, and number of weft 17; required the weight of weft to fill this length of warp.

Ans. 70 lbs. 9 oz. 7 drs.

Length of warp, 500
Breadth do. 36

18000
Pecks per inch, 56

108000
90000

h'ks. lbs. oz. drs.
Yds. in h'k,840)1008000(1200(70—9—7.
17)1200(70—9—7.
840 119

1680 10
1680 16

00 160(9
153

7

VARIOUS TABLES, &c.

TABLE A.

Showing the relative power of Overshot Wheels, Steam Engines, Horses, Men, and Windmills of different kinds, by FENWICK.

No. of Ale gallons delivered on overshot wheel 10 ft. diameter, every minute.	Diameter of cylinder in the common steam engine, in inches.	Diameter of the cylinder in the improved steam engine, in inches.	No. horses working 12 h'rs per day, and moving at the rate of 2 miles pr hr.	No. of men working 12 hours a day.	Radius of Dutch sails in their *common* position in feet.	Radius of Dutch sails in their *best* position in feet.	Radius of Mr. Smeaton's enlarged sails in feet.	Height to which these different powers will raise 100 lbs. avoir. in a min.
230	8.	6.12	1	5	21.24	17.89	15.65	13
390	9.5	7.8	2	10	30.04	25.30	22.13	26
528	10.5	8.2	3	15	36.80	30.98	27.11	39
660	11.5	8.8	4	20	42.48	35.78	31.30	52
720	12.5	9.35	5	25	47.50	40.00	35.00	65
970	14.	10.55	6	30	52.03	43.82	38.34	78
1170	15.4	11.75	7	35	56.90	47.33	41.41	90
1350	16.8	12.8	8	40	60.09	50.60	44.27	104
1455	17.3	13.6	9	45	63.73	53.66	46.96	117
1584	18.5	14.2	10	50	67.17	56.57	49.50	130
1740	19.4	14.8	11	55	70.46	59.33	51.91	143
1900	20.2	15.2	12	60	73.59	61.97	54.22	156
2100	21.	16.2	13	65	76.59	64.5	56.43	169
2300	22.	17.	14	70	79.49	66.94	58.57	182
2500	23.1	17.8	15	75	82.27	69.28	60.62	195
2686	23.9	18.3	16	80	84.97	71.55	62.61	208
2870	24.7	19.	17	85	87.07	73.32	64.16	221
3055	25.5	19.6	18	90	90.13	75.90	67.41	234
3240	26.2	20.1	19	95	92.60	77.98	68.23	247
3420	27.	20.7	20	100	95.00	80.00	70.00	260
3750	28.5	22.2	22	110	99.64	83.90	73.42	286
4000	29.8	23.	24	120	104.06	87.63	76.88	312
4460	31.1	23.9	26	130	108.32	91.22	79.81	388
4850	32.4	24.7	28	140	112.20	94.66	82.82	364
5250	33.6	25.5	30	150	116.35	97.98	85.73	396

TABLE B.

Showing the quantity of water discharged in one minute by orifices differing in form and position.

Constant height of the fluid above the centre of the orifice.	Form and position of the orifice.	Diameter of the orifice.	No. of cubic inches discharged in a minute.
ft. in. lin.		Lines.	
11 8 10	Circular and Horizontal,	6	2311
	Circular and Horizontal,	12	9281
	Circular and Horizontal,	24	37203
	Rectangular and Horizontal,	12 by 3	2933
	Horizontal and Square,	12 side.	11817
	Horizontal and Square,	24 side.	47361
9 0 0	Vertical and Circular,	6	2018
	Vertical and Circular,	12	8135
4 0 0	Vertical and Circular,	6	1353
	Vertical and Circular,	12	5436
5 0 7	Vertical and Circular,	12	628

TABLE C.

Containing the quantity of water discharged over a weir.

Depth of the upper edge of the waste board below the surface in English inches.	Cubic feet of water discharged in a minute by every inch of the waste-board, according to DuBuat's formula.	Cubic feet of water discharged in a min. by every inch of the waste-board, according to experiments made in Scotland.	Depth of the upper edge of the waste-board below the surface in English inches.	Cubic feet of water discharged in a minute by every inch of the waste-board, according to DuBuat's formula.	Cubic feet of water discharged in a minute by every inch of the waste-board, according to experiments made in Scotland.
1	0.403	0.428	10	12.748	13.535
2	1.140	1.211	11	14.707	15.632
3	2.095	2.226	12	16.758	17.805
4	3.225	3.427	13	18.895	20.076
5	4.507	4.789	14	21.117	22.437
6	5.925	6.295	15	23.419	24.883
7	7.466	7.933	16	25.800	27.413
8	9.122	9.692	17	28.258	30.024
9	10.884	11.564	18	30.786	32.710

TABLE D.

Showing the height of the fall in feet and the time of falling in seconds.

Height of fall in feet.	Time of falling in seconds.	Height of fall in feet.	Time of falling in seconds.
1	.25	12	.864
2	.352	14	.935
3	.432	16	1.
4	.5	20	1.117
5	.557	25	1.25
6	.612	30	1.37
7	.666	36	1.5
8	.706	40	1.58
9	.75	45	1.67
10	.79	50	1.76

TABLE E.

Showing the average velocity of the current of Rivers, calculated from the velocity of the surface in the middle of the stream.—ROBINSON.

Surface.	Bottom.	Mean.	Surface.	Bottom.	Mean.
1	0.000	0.5	31	20.857	25.924
2	0.172	1.081	32	21.678	26.839
3	0.537	1.768	33	22.506	27.753
4	1.	2.5	34	23.339	28.660
5	1.526	3.263	35	24.167	29.583
6	2.1	4.050	36	25.	30.5
7	2.709	4.854	37	25.827	31.413
8	3.342	5.67	38	26.667	32.333
9	4.	6.5	39	27.51	33.255
10	4.674	7.33	40	28.345	34.172
11	5.369	8.184	41	29.192	35.096
12	6.071	9.036	42	30.030	36.015
13	6.786	9.893	43	30.880	36.940
14	7.553	10.756	44	31.742	37.871
15	8.254	11.622	45	32.581	38.79
16	9.	12.5	46	33.432	39.716
17	9.753	13.376	47	34.293	40.646
18	10.463	14.231	48	35.151	41.570
19	11.283	15.141	49	36.	42.5
20	12.055	16.027	50	36.857	43.428
21	12.830	16.837	51	37.712	44.356
22	13.616	17.808	52	38.564	45.282
23	14.202	18.70	53	39.438	46.219
24	15.194	19.597	54	40.284	47.142
25	16.	20.5	55	41.165	48.082
26	16.802	21.401	56	42.016	49.008
27	17.606	22.303	57	42.968	49.984
28	18.421	23.210	58	43.771	50.886
29	19.228	24.114	59	44.636	51.818
30	20.044	25.022	60	45 509	52.754

TABLE F.

Of the elasticity of Steam.—By M. ARAGO and others.

Elasticity of ste'm, the pres. of the atmosphere being 1.	Corresponding temp. in deg. of Fahrenheit.	Elasticity of ste'm, the pres. of the atmosphere being 1.	Corresponding temp. in deg. of Fahrenheit.
1	212.	13	380.66
$1\frac{1}{2}$	234.	14	386.94
2	250.5	15	392.86
$2\frac{1}{2}$	263.8	16	398.48
3	275.2	17	403.83
$3\frac{1}{2}$	285.	18	408.92
4	293.7	19	413.78
$4\frac{1}{2}$	300.3	20	418.46
5	307.5	21	422.96
$5\frac{1}{2}$	314.24	22	427.28
6	320.36	23	431.42
$6\frac{1}{2}$	326.26	24	435.56
7	331.7	25	439.34
$7\frac{1}{2}$	336.86	30	457.16
8	341.78	35	472.73
9	350.78	40	486.59
10	358.78	45	499.24
11	366.85	50	510.6
12	374.		

TABLE G.

Showing the force and heat of Steam.

Steam predominating over the pressure of the atmosphere upon a safety valve, if its elastic force be equal to [pounds, first column] pounds per square inch, requires to be maintained by a temperature equal to [second column] degrees of heat by Fahrenheit's thermometer, and at these respective degrees of heat, steam can expand itself to about [third column] times its volume, and yet continue equal in its elasticity to the pressure of the atmosphere.

5	227½	5
6	230¼	6
7	232¾	7
8	235¼	8
9	237½	9
10	239½	10
15	250½	15
20	259½	20
25	267	25
30	273	30
35	278	35
40	283	40

TABLE H.

Showing the expansive force of steam, expressing the degrees of heat at each lb. of pressure on the safety valve.

Degrees of heat.	Lbs. of pressure.	Degrees of heat.	Lbs. of pressure.	Degrees of heat.	Lbs. of pressure.
212°	0	268°	24	298°	48
216	1	270	25	299	49
219	2	271	26	300	50
222	3	273	27	301	51
225	4	274	28	302	52
229	5	275	29	303	53
232	6	277	30	304	54
234	7	278	31	305	55
236	8	279	32	306	56
239	9	281	33	307	57
241	10	282	34	308	58
244	11	283	35	309	59
246	12	285	36	310	60
248	13	286	37	311	61
250	14	287	38	312	62
252	15	288	39	313	63
254	16	289	40	313½	64
256	17	290	41	314	65
258	18	291	42	315	66
260	19	293	43	316	67
261	20	294	44	317	68
263	21	295	45	318	69
265	22	296	46	319	70
267	23	297	47	320	71

TABLE I.

Showing the elastic force of steam,—by Dr. URE.

Temp.	Elastic force.	Temp.	Elastic force.	Temp.	Elastic force,	Temp.	Elastic force.
24°	0.170	155°	8.500	242°	53.600	218.8°	104.400
32	0.200	160	9.600	245	56.340	283.8	107.700
40	0.250	165	10.800	245.8	57.100	285.2	112.200
50	0.360	170	12.050	248.5	60.400	287.2	114.800
55	0.416	175	13.550	250	61.900	289	118.200
60	0.516	180	15.160	251.6	63.500	290	120.150
65	0.630	185	16.900	254.5	66.700	292.3	123.100
70	0.726	190	19.000	255	67.250	294	126.700
75	0.860	195	21.100	257.5	69.800	295	129.000
80	1.010	200	23.600	260	72.300	295.6	130.400
85	1.170	205	25.900	260.4	72.800	297.1	133.900
90	1.360	210	28.880	262.8	75.900	298.8	137.400
95	1.640	212	30.000	264.9	77.900	300	139.700
100	1.860	216.6	33.400	265	78.040	300.6	140.900
105	2.100	220	35.540	267	81.900	302	144.300
110	2.456	221.6	36.700	269	84.900	303.8	147.700
115	2.820	225	39.110	270	86.300	305	150.560
120	3.300	226.3	40.100	271.2	88.000	306.8	155.400
125	3.380	230	43.100	273.7	91.200	308	157.700
130	4.366	230.5	43.500	275	93.480	310	161.300
135	5.070	234.5	46.800	275.7	94.600	311.4	164.800
140	5.770	235	47.220	277.9	97.800	312	167.000
145	6.600	238.5	50.300	279.5	101.600	312	165.5
150	7.530	240	51.700	280	101.900		

TABLE J.

Showing the velocity of motion for boring and turning.

BORING.		TURNING.	
Inches diameter.	Revolution of shaft per minute.	Inches diameter.	Revolution of shaft per minute.
1	25.	1	50.
2	12.5	2	25.
3	8.33	3	16.67
4	6.25	4	12.50
5	5.	5	10.
6	4.16	6	8.32
7	3.57	7	7.15
8	3.125	8	6.25
9	2.77	9	5.55
10	2.5	10	5.
15	1.66	15	3.33
20	1.25	20	2.50
25	1.	25	2.
30	0.833	30	1.667
35	0.714	35	1.430
40	0.625	40	1.250
45	0.56	45	1.12
50	0.5	50	1.
60	0.417	60	0.834
70	0.358	70	0.716
80	0.313	80	0.626
90	0.278	90	0.556
100	0.25	100	0.50

It will be seen that the velocity of turning is double that of boring. Many turners prefer different velocities, but the above is generally considered to be advantageous. The progression of the cutter is from $\frac{1}{16}$th to $\frac{1}{20}$th for the first, and $\frac{1}{20}$th to $\frac{1}{24}$th of an inch for the second cut.

TABLE K.

Of the Specific Gravity of Metals.

	Specific gravity.		Specific gravity.
Arsenic,	5763	Cast bismuth,	9822
Cast antimony,	6702	Cast silver,	10474
Cast zinc,	7190	Hammered silver,	10510
Cast iron,	7207	Cast lead,	11352
Bar iron,	7788	Mercury,	13568
Cast tin,	7291	Jeweller's gold,	15709
Cast nickel,	7807	Gold coin,	17647
Cast cobalt,	7811	Cast gold, pure,	19258
Hard steel,	7816	Pure gold, hammered,	19361
Soft steel,	7833	Platinum, pure,	19500
Cast brass,	8395	Platinum, hammered,	20336
Cast copper,	8788	Platinum wire,	21041

TABLE L.

Specific gravity of Gases, that of atmospheric air being=1.

	Specific gravity.		Specific gravity.
Hydrogen,	0.0694	Carbonic acid,	1.5277
Carbon,	0.4166	Alcohol vapor,	1.6133
Steam of water,	0.481	Chlorine,	2.500
Ammonia,	0.5902	Nitrous acid,	2.638
Carburetted hydrogen,	0.9722	Sulphuric acid,	2.777
Azote,	0.9723	Nitric acid,	3.75
Oxygen,	1.1111	Oil of turpentine,	5.013
Muriatic acid,	1.2840		

TABLE M.

Showing the No. of Wire generally used in carding, from 12's to 40's.

Top sheets, 24, 28, 32, three or four of each kind to the card.
Main cylinder sheets, 90 to 100, or 105, four inches wide.

Filleting, or fillets for		Doffer,	115 to 120	do.	do.
Do.	do.	Licker in,	75	do.	do.
Do.	do.	Cleaners,	85 to 90	do.	do.

TABLE N.

Showing the scale of Sheets and Filletings.—MONTGOMERY.

To Card for all sizes of Yarn,	Cylinder sheets.	Crowns.	Tops, 1st, 2d and 3d.	Crowns.	Tops, 4th, 5th, 6th, 7th, 8th.	Crowns.	Tops, 9th, 10th, and 11th.	Crowns.	Breadth of top sheets.	Filletings.	
Between No. 10 and No. 36.	80	8	20	7	26	7	28	8	$1\frac{1}{2}$	90	Breakers.
	80	9	24	8	28	8	30	8	$1\frac{1}{2}$	90	Finishers.
Between No. 36 & No. 100.	80	9	26	7	30	8	35	9	$1\frac{1}{2}$	90	Breakers.
	90	10	30	8	35	9	40	10	$1\frac{1}{2}$	100	Finishers.
Between No. 100 & No. 200.	90	10	30	8	38	9	40	10	$1\frac{1}{2}$	100	Breakers.
	100	12	35	9	40	10	45	12	$1\frac{1}{2}$	110	Finishers.

TABLE O.

Showing the draught produced by any change wheel from 20 *to* 35 *teeth, assuming the top carrier to have* 72 *teeth, the back roller wheel* 56, *and the pinion on front roller* 18 *teeth. Diameter of front roller* 1, *and back roller* $\frac{7}{8}$ *of an inch.*

Grist Pinions.	Draughts.	Grist Pinions.	Draughts.	Grist Pinions.	Draughts.	Grist Pinions.	Draughts.
20	12.8	24	10.66	28	9.14	32	8.00
21	12.18	25	10.24	29	8.82	33	7.75
22	11.63	26	9.84	30	8.52	34	7.52
23	11.12	27	9.48	31	8.25	35	7.31

TABLE P.

Showing the draught produced by any change wheel from 20 to 35 teeth, assuming the top carrier to have 116 teeth, the back roller wheel 64, and the pinion on front roller 27 teeth. Diam. of front roller $1\frac{1}{8}$, and back do. $\frac{7}{8}$ inch.

Grist Pinions.	Draughts.	Grist Pinions	Draughts.	Grist Pinions.	Draughts.	Grist Pinions	Draughts.
20	17.6	24	14.69	28	12.64	32	11.03
21	16.8	25	14.10	29	12.18	33	10.70
22	16.03	26	13.56	30	11.77	34	10.39
23	15.33	27	13.07	31	11.39	35	10.09

TABLE Q.

Showing the distances at which the rollers should be set in using different lengths of cotton.

If the length of staple be	$\frac{7}{8}$	inches with a dra'ht of from	$1\frac{1}{2}$ to 7	inches, the distance between the rollers ought to be	$\frac{7}{8}$ to $1\frac{1}{8}$	in's fr'm centre to centre.
	1		$1\frac{1}{2}$ to 7		1 to $1\frac{3}{16}$	
	$1\frac{1}{8}$		$1\frac{1}{2}$ to 7		$1\frac{1}{8}$ to $1\frac{3}{8}$	
	$1\frac{3}{16}$		$1\frac{1}{2}$ to 7		$1\frac{3}{16}$ to $1\frac{5}{8}$	
	$1\frac{1}{2}$		$1\frac{1}{2}$ to 7		$1\frac{1}{4}$ to $1\frac{6}{16}$	

TABLE R.

Showing the gain of carriage necessary for spinning various numbers.

For spinning numbers from No's	25 to 30	the gaining of carriage ought to range from	$1\frac{1}{4}$ to $2\frac{3}{4}$	inches per stretch of 50 to 58 inches.
	35 to 45		$2\frac{1}{2}$ to $4\frac{1}{2}$	
	45 to 55		$4\frac{1}{2}$ to $5\frac{1}{2}$	
	55 to 65		$5\frac{1}{2}$ to 6	
	65 to 70		$6\frac{1}{2}$ to 7	

TABLE S.

Showing the diameters of Shaft Journals with horse power of engine.—GRIER'S Works, p. 162.

	10	20	30.	40.	50.	60.	70.	80.	90.	100.
5	5.9	4.7	4.1	3.7	3.5	3.3	3.1	3.0	2.9	2.7
6	6.3	5.0	4.4	4.0	3.7	3.5	3.4	3.2	3 0	2.9
7	6.6	5.2	4.6	4.2	3.9	3.6	3.5	3.4	3.3	3.1
8	6.9	5.5	4.8	4.4	4.1	3.9	3.7	3.5	3.4	3.3
9	7.2	5.7	5.0	4.5	4.2	4.0	3.7	3.6	3.5	3.4
10	7.4	5.9	5.2	4.7	4.4	4.1	3.9	3.7	3.6	3.5
15	8.5	7.0	6.0	5.5	5.1	4.6	4.5	4.3	4.2	4.0
20	9.3	7.4	6.6	5.9	5.6	5.2	5.0	4.6	4.5	4.4
30	10.7	8.4	7.4	6.9	6.5	5.9	5.7	5.5	5.2	5.0
40	11.7	9.5	8.3	7.4	6.9	6.6	6.2	5.9	5.7	5.6
50	12.6	10.0	9.0	8.0	7.4	7.2	6.8	6.5	6.2	5.9
60	13.6	10.8	9.3	8.6	7.7	7.4	7.2	6.8	6.7	6.4

In the above table, the No. of horse power of engine are found in the left hand column, and the No. of revolutions per minute of shaft are found in the top column. To find the diameter of shaft, look for power of engine in the side column, and the No. of turns of shaft per minute in top column, and where these points meet is found the diameter of shaft. Thus: the journal of a shaft is required of a 40 horse power engine, the shaft making 30 revolutions per min. By tracing these numbers to the points, or where these columns meet, we find 8.3 = the diameter of shaft in inches.

USEFUL RECIPES FOR WORKMEN.

SOLDERS.

"*For Lead.* Melt one part of block tin, and when in a state of fusion, add two parts of lead. If a small quantity of this, when melted, is poured on the table, there will, if it be good, arise little bright stars upon it. Resin should be used with this solder.

For Tin. Take four parts of pewter, one of tin, and one of bismuth; melt them together, and run them into thin slips. Resin is also used with this solder.

For Iron. Good tough brass, with a little borax.

CEMENTS.

" A very strong glue is made by adding some powdered chalk to common glue when melted ; and a glue which will resist the action of water, may be formed by boiling one pound of common glue in two quarts, (English measure) of skimmed milk."

An excellent cement for fastening leaders, or joining laps, is made as follows: Take of good glue 5 parts and let it dissolve; when hot, pour 3 parts of Venice turpentine, and let them warm (not boil) moderately 3 or 4 hours; if it is by heating too thick, add vinegar. Apply it quite warm, and let it dry. This is a very strong and permanent cement.

VARNISH FOR TOP ROLLERS.

1. Take of gum tragacanth 1½ oz. and dissolve it in a pint of water. 2. Take ½ pint spts. vinegar, in

this put $\frac{1}{2}$ oz. alum and $\frac{1}{2}$ oz. borax ; then, for $\frac{1}{2}$ pint of varnish take one-fourth part good glue, one table-spoonful of the tragacanth, (dissolved) two table-spoonsful of the alum and borax; then put in vinegar to thin, and chrome yellow, (or any other color) sufficient to give it a coat. Apply to rollers when warm, and give from three to seven coats.

AN EXCELLENT COMPOSITION

For appeasing the heating of journals exposed to great friction, is made by melting equal parts of tallow and beeswax and adding to this liquid, to the consistency of a paste, the common polishing lead or lustre. This composition forms itself into a new metal on the surface of the bearing, filling all inequalities and presenting to the eye a smoothness of finish not to be exceeded by the most skilful turner. All impurities should be removed from the box and journal previous to its application. But a thin coat should be put on at once. This answers as well on the cogs of wheels that have a tendency to wear roughly.

Where shafts are required to run with great velocity, it is a good plan to fit pieces of zinc to the boxes. This metal, being a non-conductor, answers its purpose quite well. Many of the collars or rests of spindles are made from this, and other malleable metals combined. Sheets of fine pasteboard compressed so that their edges are exposed as bearings, serve a very good office for wide boxes.

A composition for the same purpose is much in use in fine mills, formed of brass 4 parts, of lead 1 part and malleable iron 1 part, &c.

It is often the case, that the common brass bearings of the Lapping Machine are lined with refined steel; this answers a very good purpose, but it is a fact which trial has well substantiated, that good cast iron skilfully wrought and fitted, will last as long, if not longer, than brass, steel or any other metal as yet ever used. This remark will apply to the numerous other uses made of this metal.

MISCELLANEOUS PRACTICAL QUESTIONS.

These exercises are intended as illustrations of the mode of calculating the changes and operations which are so frequently required in the course of cotton manufacturing. The manager can readily vary them, or substitute others, as the occasion may require.

To find the number or size of yarn from having the weight and length of lap given at the Carding engine.

Multiply the length of lap by the draughts through the whole process, and divide this result by the number of doublings, and you have the length in inches of the lap. Divide this result by the circumference, *multiplied by the threads in a lea, and the leas in a hank,* and you have the hanks produced ; then say by pro-

portion, as the weight of lap—the allowance made for flowings, waste, &c., is to number drachms in one pound, so are the number hanks produced, to the hanks in one pound.

1. Suppose the weight of lap to be 118 drachms, the length of do. 67 inches, and the draught as follows. The draught of Carding Engine 74. The draught of Drawing Frame, 1st head, 7.5×2d head, 7.5×3d head, 7.5=421.875. The draught of Speeder 10.50. The draught of Mule jenny 9.75. The number of doublings 528, and the allowance for flowings, tops, &c., 8 drachms. Required the number of yarn.

Thus:

Draught Drawing Fr.,	421.875
do. Carding Engine,	74
	1687500
	2953125
	31218.750
do. Speeder,	$10\frac{1}{2}$
	15609375
	312187500
	327796.875
do. Mule jenny,	$9\frac{3}{4}$
	1638984375
	8194921875
	2950171875
	3196019.53125

```
                3196019.53125
Length of lap,             67
               ──────────────
               22372136718750
              19176117187500
              ──────────────
No. dbls., 528)214133308.59375(405555.508.
               2112
               ────
                2933                  Cir. of reel,     54 in.
                2640                  Threads in lea,   80
                ────                                  ────
                 2933                                 4320
                 2640                 Leas in hank,      7
                 ────                                ─────
                  2930                               30240
                  2640
                  ────
                   2908
                   2640
                   ────
                    2685
                    2640
                    ────
                     4593
                     4224
                     ────
                      3697
```

Now, number of inches produced from

```
lap÷30240)405555.508(=13.41  hanks produced
          30240                from the lap of
          ─────                  118 drachms.
          103155
           90720
          ──────
           124355
           120960
           ──────
             33950
             30240
             ─────
              3710
```

The hanks produced from the 118 drs. are 13.41. Now to find the hanks produced from *one* pound, we

subtract the 8 drs. for flowings, &c., and then say as the remainder is to the *drs. in one pound*, so are *the hanks produced from the* 118 *drs., to the hanks in one pound.*

Weight of lap, 118 drs.
Loss flowings, &c., 8 drs.

```
                    in pound.
110  :  256  ::  13.41
                   256
                 -----
                  8046
                 6705
                2682
                ------
           110)3432.96(31.20 size
                330           of yarn.
                ---
                 132
                 110
                 ---
                  229
                  220
                  ---
                   96
                  ---
                  110
```

To find the size of roving.

Multiply the number of teeth in the counter wheel, by teeth in the bell wheel, and this product by the cir. of the front roller, and this latter product by the number of spindles, for a dividend.

Then for a divisor, multiply the cir. of reel by the threads in a lea, and this product by the leas in a hank.

Counter wheel, say is	20	Cir. of reel,	54 in.
Bell wheel,	125	Thr'ds in lea,	80
	2500		4320
Cir. of front roller,	3.54	Leas in hank,	7
	10000		30240
	12500		
	7500		
	8850.00		
Spindles, say	112		
	1770000		
	885000		
	885000		

30240)991200.00(32.77.
90720

84000
60480

235200
211680

235200
211680

23520

This result multiplied by number of ounces in a pound, and divided by the weight of a set of rovings, will give the size of roving required.

```
                         32.77
                            16 ounces in a pound.
                        ------
                        19662
                    oz. 3277
                        ------
Suppose set rovings 108)524.32(4.85 size of roving.
                        432
                        ---
                         923
                         864
                         ---
                          592
                          540
                          ---
                           52
```

To find the price or cost of any mixture.

Multiply the several proportions by their respective prices, their sum divided by 100 lbs., (or any other number assumed as a denominator,) gives the price per lb. of mixture.

1. Suppose you are spinning No. 30's weft yarn from the following qualities of cotton, viz.:

100 lbs.	35 lbs. Surats,	at 5 cts.	per lb.=		175 cts.
	45 do. Orleans,	" 7	do.=		315 cts.
	10 do. Boweds,	" $6\frac{1}{2}$	do.=		65 cts.
	10 do. Waste,	" 4	do.=		40 cts.
	100			100)	595
					$5\frac{95}{100}$ pr.lb.

2. Suppose you are spinning No. 40 warp yarn from the following qualities of cotton, viz.:

100 lbs	60 lbs. Egyptians,	at 9 cts.	pr. lb.=		540 cts.
	30 do. Sea Island,	" $9\frac{1}{2}$	do.=		285 cts.
	10 do. Boweds,	$8\frac{1}{2}$	do.=		85 cts.
	100			100)	910
					$9\frac{1}{10}$ pr.lb.

3. Suppose you are spinning No. 25's warp yarn from the following qualities of cotton, viz.:

100 lbs.	50 lbs.	N. Orleans,	at $12\frac{1}{2}$	cts.=625 cts.	
	25	do. Upland,	" 12	cts.=300 cts.	
	25	do. Alabama,	" 14	cts.=350 cts.	
	100			100)1275	
					$12\frac{3}{4}$ cts. pr.

lb.=average price of mixture.

4. Required the cost per lb. of a mixture of 5200 lbs., of the following qualities of cotton, viz.:

2000 lbs.	N. Orleans,	at $10\frac{1}{2}$	cts.=21000 cts.
1800	do. Upland,	" 10	cts.=18000 cts.
1400	do. Sea Island,	" 12	cts.=16800 cts.
5200			)55800(10.73+

5. Suppose this mixture cost you $10\frac{3}{4}$ cts. per lb., and you found that the following qualities made as good a bing: required the cheaper mixture?

2500 lbs.	N. Orleans,	at $10\frac{1}{2}$	cts.=26250 cts.
1700	do. Upland,	" $9\frac{1}{2}$	cts.=16150 cts.
750	do. Sea Island,	" 12	cts.= 9000 cts.
250	do. Boweds,	" $8\frac{1}{2}$	cts.= 2125 cts.
5200			)53525(10.30.

It will be seen, that the latter is some $\frac{45}{100}$ ct. per lb. cheaper. It is a very essential point to have the cotton regularly weighed, and entered in a book for that purpose, so that the price of the yarn can be easily ascertained.

In many small mills, it is often found that a quality of cotton, *to appearance*, quite good and profitable, is not so much so, when compared with another quality

of an inferior cost and mixture. The keeping of this little book is a correct guide, and well pays for the care and attention bestowed upon it.

To find how many inches of yarn one inch of roving will make.

Multiply the drivers and driven wheels together separately, and the product of the latter divided by the former, is the number of inches of yarn made from one inch of rove.

1. Suppose the first driver is 26, the first driven 116, the second driver 30, and the second driven 58; required the inches produced.

1st driver, 26 teeth.	1st driven,	116 teeth.
2d do. 30 do.	2d do.	58
780		928
		580
		780)6728(8.62
		6240
		4880
		4680
		2000
		1560
		44

2. Suppose the back roller is $\frac{7}{8}$, and the front do. $\frac{9}{8}$ of an inch in diam., what is the difference of produce or roller draught?

Multiply the result of the drivers by diam. of back roll., and that of the driven by diam. of front roll.; the latter divided by the former is the inches produced, or draught.

$$\begin{array}{r} 780 \\ 7 \\ \hline 5460 \end{array} \qquad \begin{array}{r} 6728 \\ 9 \\ \hline 5460)60552(11.09 \\ 5460 \\ \hline 5952 \\ 5460 \\ \hline 49200 \\ 49140 \\ \hline 60 \end{array}$$

Then, 11.09—8.62=2.47=roller draught.

To find the proportionate velocities which wheels should bear to each other in order to furnish a regular speed.

Divide the difference between the less and greater velocities by the number of wheels less one of the train; this will give a mean quantity, showing the average difference that should exist between each successive wheel of the train from the least to the greatest, as in Arithmetical Progression.

What is the number of each of 3 wheels to produce 20 rev. per min, the driver having 120 teeth and making 4 rev. per min.? and what their velocities?

Ans. $\begin{cases} 120, \ 40 \text{ and } 24. \\ 4, \ 12 \text{ and } 20. \end{cases}$

Operation:

20—4=16, and 3—1=2, and 16÷2=8=average dif.

120×4÷12=40=2d wheel×12÷20=24=3d wheel.

Suppose you have a system 13 breaker engines delivering into one railway with $1\frac{1}{2}$ draught, and it is required to deliver two strands of the same size into

as many railways with no draught; how many more engines are necessary?

Ans. $4\frac{1}{3}$.

Operation:

13 engines $\div 1\frac{1}{2} = 8\frac{2}{3}$ engines with no draught, which will furnish the same weight as the 13 with the $1\frac{1}{2}$ draught. 2 railways of $8\frac{2}{3}$ engines $= 17\frac{1}{3} - 13 = 4\frac{1}{3}$ additional engines.

Suppose you have a system of 12 carding engines, delivering into a single railway of $1\frac{1}{2}$ draught, and it is required to make the sliver one-fourth lighter with no draught; how many additional engines are necessary?

Ans. $1\frac{1}{2}$.

12 engines with $1\frac{1}{2}$ railway draught, turn out the same length as 18 engines with no railway draught; then $18 \div 4$, the deduction necessary $= 4\frac{1}{2}$ and $18 - 4\frac{1}{2} = 13\frac{1}{2}$ engines with no railway stretch to give the same weight as 18 with the above draught; and $13\frac{1}{2} - 12 = 1\frac{1}{2}$ additional engines.

Other examples as familiar, might be given, but the above fully determine the mode pursued in calculation. We would hope no young man might fail to cultivate a taste for becoming perfectly acquainted with the numerous and as varions changes required in the operation of millwork.

PROBLEMS WORKED BY THE SLIDING RULE.

It will be seen that the following questions are of a general nature, embracing sufficient information for the manager, and clearly show the mode of working most any problem in the common course of millwork.

A great many works have been published, showing the use of this rule. The few remarks and explanations which follow, may be found of service to the mechanic and general reader.

This rule was invented by Edmund Gunter, and is made in a number of forms; the most common of which is that generally used as a two foot measure by carpenters.

The reader will perceive that on the face of the rule are four lines, marked A, B, C and D. A will be found on the first, B on the second, C on the third, and D on the fourth line. The three first, A, B and C, are *double* lines, one of which is on the rule, and the other two are on the slider. The latter line D, is a *single* line, and is technically called "the girt line." These lines with their letters attached to the scale, require to be familiarly understood and designated, as the problems to be performed will show. Inattention to this point will lead to confusion and blindness of ideas in using it.

The reader will perceive on his rule at the left

hand, the figure 1. This 1 may be called 1, 10, 100, or *any number* whose right hand figures are composed of cyphers. If we call it 1, then the next right hand figure 2 must be called two, and 3 three, 4 four, and so on until we come to another figure 1, which in this case must be called 10. Now, as we annex a cipher to *this* 1, we must also annex one to 2, making 20, and so on, until we come to 10, which now becomes 100. Again, suppose we call the figure 1 at the left hand 100, then the 2 becomes 200, and so on until we come to 1 again which becomes 1000. This ratio must be clearly understood.

Again, you will perceive two parallel lines running the whole length of the scale on every line of the several divisions. Now their use is this; say we wish to find any odd number, 13 for instance. We call the 1 (in middle of scale,) 10, and as there are ten divisions, each divided into five spaces, making 50 in all from this 1 or 10 to the 2 or 20 on the right, we find that five spaces make 1 whole number; then 15 spaces from the right of 1 or 10 will make the difference between 10 and 13, viz., 3. Suppose we wanted 15. We count on to the right 2 numbers, (10 spaces,) and find that a line or stroke projects above the parallel lines of A; this is 15, this stroke indicating the central distance, or point between 10 and 20; to find 16 we have only to count 5 more spaces, and so on until we come to 2 or 20.

Again, suppose we wanted 23, on A. We perceive that between 2 and 3, or 20 and 30, there are 10 spaces corresponding to the difference between 20

and 30 ; now a little reflection will convince us that every space here must count *one;* then to find 23 we count 3 more of these spaces: suppose you wanted 25 on A, or B; all we have to do is to count 5 spaces to the right of 2 or 20, or 2 more than in the last instance ; here, we perceive as above, a point projecting above the parallel lines and for the same reason, viz., to show the half-way distance or point. Suppose we wanted $25\frac{1}{2}$ or 25.5. We perceive that between our means, viz., 20 and 30 there are short lines or points extending only to the first or lower line of the parallel lines on A.; now these are *halves of one, or unity ;* then all we have to do to find our number 25.5 is to count one of these short spaces to the right of the whole number 25 ; if we want 28.5, all we have to do is to count to the right of 2 or 20 the number of spaces corresponding to the difference between these numbers ; and so on for any number or fraction between the 20 and 30.

Again, the reader will perceive that between 3 and 4 or 30 and 40 there are but ten points or spaces; and that of course every one must count 1. Suppose we want 32; count 2 spaces (the difference between the numbers 30 and 32,) and we have it; if we want 35, count 5 spaces to the right of 3 or 30 and we find the number directly on the projecting point in the middle, between the 30 and 40. The other figures and spaces to the right of those of which we have spoken, are used similarly, the number of *spaces* in every instance being the same, though in a shorter distance or scale.

Let us in part review our observations, and *first*, begin back at the left hand of our rule and call the 1 *one hundred ;* then of course it follows that 2 must called *two hundred*, 3 *three hundred*, and so on of the other right hand figures. Now, we perceive between 1 and 2, (assumed here as 100 and 200,) there are *ten* spaces or divisions that project to the top of the parallel lines on A ; therefore, each space *counts ten.*

Again, we perceive that each of these spaces or divisions are divided into *five equal parts*, making in all 50 spaces ; and for every space the number 2, or, in other words, every space will here count 2 ; for $10 \div 5 = 2$. Now, if we wanted to find 108, we count to the right of 1, that is, 100, four of these spaces and it gives us the point or place that stands for the number 108. If we wanted to find 120, we count to the right two of the *longer* spaces and we have the position, and so on for any number between our means, 1 and 2, assumed as 100 and 200.

Again, the reader will percieve between the next division of the scale, (from 2 to 3,) assumed as 200 and 300, there are ten spaces that project to the *top* of the parallel lines on A ; each one of these counting ten. By referring to the rule we perceive that these spaces are divided by lines extending to the *lower* or bottom of the parallel lines on A ; each one of these shorter spaces will count five, for $10 \div 2 = 5$, and $5 \times 2 = 10 \times 10 = 100 =$ number spaces between the 2 and 3, assumed here as 200 and 300.

Again, let us take the third division, viz., 3 and 4 ; here we perceive as before, 10 spaces, and that

each space must count *ten*. If we wanted to find 310 we count one space to the right of 300, and we have it. If 380, we count eight spaces to the right of 300, and find the point. and so on for any number.

The other divisions of the scale to 1, (in this case 1000,) are the same in their position and value as those between 300 and 400.

Once more, we perceive that nearly in the middle of our rule is the figure 1. Now, as has been intimated, we may call this 10, 100, 10,000 or *any* number whose left hand figure is 1; with cyphers annexed. But we must bear in mind the ratio: If this 10 is called 1000, then the 2 at the right must be called 2000, and if the former is called 10,000 or 1,000,000, then the latter must be called 20,000, or 2,000,000.

By referring to the rule we perceive between the numbers 1 and 2, (assumed here as 1000 and 2000,) there are ten spaces that project to the *top* of the parallel lines on A; therefore, each one of these must count for 100, (for $1000 \div 10 = 100$,) and also, that these last spaces are subdivided into five parts; therefore, each small space projecting to the *lower* parallel line on A, must count for twenty, for $100 \div 5 = 20$.

The reader will not fail of *thoroughly understanding* the foregoing observations, before attempting to use the rule. The divisors and guage points for measuring the distances, weight, solidity, proportions, &c., of different properties, bodies, &c., are given in the following tables compiled from authentic sources and experience.

TABLE I.

Showing the guage points of metals, &c., &c., in inches.

	Cyl.	Square.		Cyl.	Square.
Cast Iron,	2.20	1.95	Brick,	4.19	3.71
Bar Iron,	2.18	1.90	Slate,	3.63	3 20
Steel,	2.122	1.88	Stone,	3.80	3.40
Copper,	2.	1.77	Sand,	4.81	4.25
Brass,	2.047	1.814	Oak,	6.02	5.34
Lead,	1.761	1.561	Elm,	7.956	7 05
Tin,	2.195	1.94	Beech,	6.15	6.33
Zinc,	2.21	1.96	Pine,	7.33	6.47

TABLE II.

Showing the guage points of different properties in feet, in feet and inches, and in inches.

	Square.			Circular.		Globe.	
	FFF.	FII.	III.	FI.	II.	F.	I.
Cubic Inches,	578	83	1	106	1273	105	191
Cubic Feet,	1	144	1728	1833	22	191	33
Wine Gals.,	134	1925	231	245	264	235	441
Ale Gals.,	163	235	282	299	359	312	538
Imp'l Gals.,	16	231	2773	294	353	3064	5295
Water,	16	231	2773	294	353	3064	5295
Gold,	814	1175	141	149	179	155	269
Silver,	15	216	261	276	334	286	5
Mercury,	118	169	203	216	25	225	389
Brass,	193	218	333	354	424	369	627
Copper,	18	26	312	331	394	345	595
Lead,	141	203	243	258	31	27	465
Wt. Iron,	207	297	357	378	453	394	682
Tin,	219	315	378	401	481	419	723
C. Iron & Zinc,	222	32	384	407	489	424	733
Steel,	202	292	352	372	448	385	671
Coal,	127	183	22	233	22	242	42
Free Stone,	632	915	11	1162	14	121	21

TABLE III.

Showing the guage points for area of polygons from 3 to 12 sides.

3	4	5	6	7	8	9	10	11	12
.433	1.000	1.720	2.598	3.634	4.828	6.182	7.694	9.366	11.196

TABLE IV.

Showing the guage points of a circle, &c.

Area.	C. & A.	C. & D.	S. R. J.	S. E.	S. T.
7854	0795	3.1416	141	886	115

TABLE V.

Showing the diam. and guage points of pumping engines.

Diam.	G. P.	Diam.	G. P.	Diam.	G. P.	Diam.	G. P.
3	165	10	176	17	528	24	406
4	292	11	222	18	591	25	114
5	457	12	264	19	696	26	124
6	66	13	308	20	731	27	134
7	89	14	358	21	81	28	143
8	117	15	412	22	885	29	154
9	148	16	468	23	97	30	165

TABLE VI.

Showing the guage points used in finding the solid feet of timber of polygonal sides from 3 to 12 sides.

3	4	5	6	7	8	9	10	11	12
18.24	12.00	9.11	7.46	6.30	5.45	4.825	4.325	3.925	3.600

SECTION I.

WATER WHEEL.

1. Suppose you have a water wheel driving 100 looms and preparation, 24 feet in diam., running 7 feet per second; how many revolutions per min. does it make?

Operation:

Bring 22 on B to 7 on A, then under 24 the diam. of wheel, is found the circumference on B.=75.43 ft.

And if 1 second is taken for 7 feet to pass, how many seconds will be taken for 75.43 feet to pass? and how many turns per min.?

Operation:

Bring your 7 feet on B to 1 second on A, then over the cir. of wheel 75.43 on B. is found the number of seconds it takes for the wheel to make *one turn*;= 10.77 seconds nearly. Then to find the number of turns in one minute, bring 10.77+ on B to 1 rev. on A, and over 60 seconds on B is the rev. per min. on A=5.57 rev.

2. A water wheel 30 feet in diam., revolves 5.5 feet per second, how many rev. per min. does it make?

Ans. 3.5.

3. Suppose a water wheel is 18 feet in diam., and turns 4.56 times per min.; required its speed or velocity per sec.

Ans. 4.29.

SECTION II.

VELOCITY OF STREAM OF WATER.

To find the fall when the velocity per second is known.

1. Suppose two cords are strung across a stream 18 feet from each other, and you have found by experiment, that a piece of cork moved from one to the other in just 1 second; required the fall of the stream.

Ans. 5.05 nearly.

Operation:

Set 64 on C to 64 on D, and over 18 on D is found the fall 5.05 on C.

2. Suppose the same cords to be placed lower down the stream and you find the velocity per second is 21 feet. What is the fall?

Ans. 6.90.

To find the velocity when the fall is known.

1. Suppose you know the fall of a river to be 5 ft.; what is its velocity per second? *Ans.* 25 ft.

Operation:

Set 64 on C to 5 on D, and over 64 on B you have 25 on A.

2. Suppose the fall is $4\frac{1}{2}$ feet; required its velocity per second.

Ans. 20.25 nearly.

SECTION III.

SPEED OF DRUMS.

To find the revolutions per min. of the driven pulley, when the driver, its number of revolutions, and the driven pulley are given.

1. Suppose the driver is a 24, turning 150 rev. per min., how many rev. per min. will the driven of 16 inches make? *Ans.* 225.

Operation:

Set your slider (inverted) 24 on C to 150 on A, and over 16 on C is 225 on A.

2. Suppose the driver is 18 inches, making 150 rev. per min., how many rev. per min. will the driven of 14 inches make? *Ans.* 192.85 or $192\frac{12}{14}$.

3. Suppose the driver is a 20, making 175 rev. per min., how many rev. will the driven of 17 make? *Ans.* 206 nearly.

4. Suppose the shaft driving the carding engine turns 110 rev. per min. with a 16 inch pulley driving the belt pulleys of 14 inches; required the speed per min. of cylinder. *Ans.* 125.7.

Operation:

Invert your slider and set 16 on C to 110 on A, and over 14 on C is 125.7 nearly on A.

When more requires less, or less requires more, the slider is inverted in its position. This and its other features, the reader will readily understand.

To find the diameter of a driven wheel that shall make any required number of turns in the same time as the driver, when the driver and its revolutions per minute are given.

1. Suppose the diameter of your driving pulley is 18 inches, making 200 revolutions per minute, and you wish to drive the cylinder of the ring traveler 600 turns per minute, what sized pulley is required on the end of the cylinder? *Ans.* 6 inches.

Operation. Bring the diameter of the driver 18 on C to its rev. per min., 200 on A, and under the revolutions required, 600 is the diam. of pulley that will give the same on C.

2. Suppose your driving pulley is 17 inches, making 115 rev. per min. and you wish to start your looms at 120 pecks per minute; what sized belt pulleys do you require? *Ans.* 16.3 nearly.

3. Suppose a line of shafting revolving 150 turns per min. with an 18 inch pulley, and you want to run your rims 135 turns per min.; what sized belt pulleys must you order? *Ans.* 20 inches.

4. If the driver of a fan is 20 inches making 300 rev. per min. what is the diam. of small pulley on end of same to make 2000 rev. per min. *Ans.* 3 inches.

To change or alter the driving pulley.

1. Suppose you have a 9 inch pulley on throstle frame, which is required to be driven 150 rev. per min.; required the diam. of the driver that makes 100 rev.? *Ans.* 13.5 inches.

Operation. Bring 9 diam. of driver pulley on C, to the number of rev. required on A, 150, then under the rev. of the driver is found the diam. of pulley on C, 13.5 inches.

2. The driver is 7 inches, and is required to run 350 rev. per min. What is the diam. of the driver that makes 200 rev.? *Ans.* 12.25 inches.

SECTION IV.

SPEED OF GEARING.

1. Suppose the driver is 100, making 45 revolutions and the driven 60: required its rev. per min.

Ans. 75 rev.

Operation. Bring the driver on C to its rev. per min. on A, and over the driven on C, you have the rev. on A.

2. Suppose the driver is 84, making 90 rev. per min., and the driven is 36; required its rev. per min.?

Ans. 210 rev.

3. The circle of a water wheel contains 450 teeth and makes 5 rev. per min., the first driven contains 40 do.; required the number of its rev. per min.?

Ans. 56.25.

When the driver, and its revolutions per minute are given, to find the driven that shall make a required number of revolutions in the same time.

1. Suppose the driver has 80 teeth, making 96 rev. per min.; required the driven to make 128 in the same time? *Ans.* 60.

Operation. Bring the driver 80 on C to its rev. per min., 96 on A, and under the required rev. 128 on A, is the driven on C.

2. If the driving pulley of the lapping-machine of 20 inches turns 280 rev. per min., what must be the diam. of the beater pulley to make 1600 rev. in the same time? *Ans.* 3.5 inches

Operation. Set 20 on C to 280 on A, and over 1600 on C is $3\frac{1}{2}$ or 3.5 on A.

3. Suppose the rim to a mule jenny is 36 inches, making 125 rev. per min.; required the size or diam. of large twist pulley to make 400 rev. in same time? *Ans.* 11.25 or $11\frac{1}{4}$ inches.

SECTION V.

TWIST.

1. Suppose the front roller of the fly frame is $1\frac{1}{4}$ inches in diam. making 200 rev. per min., and the flyer makes 900 rev. per min. What twist per inch is given to the rove? *Ans.* 1.14 per twist.

Operation. Bring 22 on B to 7 on A, and over $1\frac{1}{4}$ or 1.25 on B is 3.93 nearly on A, the cir. of roller.

And if 3.93 inches are made in 1 *turn*, how many inches are made in 200 *turns?* *Ans.* 786 nearly.

Operation. Bring 200 on B to 1 on A, and under 3.93 on A is 786 on B.

And if 786 inches are turned out per min. and 900 turns of flyer are made per min., what is the twist per inch?

Operation. Bring 786 on B to 900 on A, and over 1 on B you have 1.14 + on A.

2. If the diam. of front roller is 1 inch, making 75 rev. per min., how many inches are turned out?

Ans. 235.50.

Operation. Bring 22 on B to 7 on A, and over 75 on B is 235.70 on A.

What is the twist given per inch, supposing the spindle to make 6000 turns per min.?

Ans. 25.5 nearly.

Operation. Bring 235.70 on B to 1 on A, and over 6000 on B is 25.5 nearly on A.

3. If 300 inches of yarn are turned out per min., and the spindle makes 6150 turns, what is the twist per inch? *Ans.* 20.5 twist.

4. If 400 inches are turned out and the spindle makes 6200 rev. per min., what is the twist per inch?

Ans. 15.5 twist.

5. If the slubbing machine turns out 190 inches per min. and the flyer makes 228 turns per min., what twist per inch is given the roving?

Ans. $1.20 = 1\frac{1}{5}$ twist.

Operation. Bring 190 on B to 1 on A, and over 228 on B is 1.20 on A.

SECTION VI.

DRAUGHTS.

1. Required the draught of a machine whose drivers and driven wheels are as follows, viz.:

First driver,	26 teeth.	First driver,	116 teeth.
Second do.	30 "	Second do.	60 "
Back roller,	$\frac{7}{8}$ inch.	Front roller,	1 inch.

Here it will be seen, are 6 numbers given to find 1: now we cannot use them all at once upon our rule, and for this reason, we take the first driver, (26) and the first driven, (116) for our first movement, and bring the first driven 116 on B, to the first driver 26 on A: then under 1 inch on A we find the draught given by these two wheels on B, which is 4.46 nearly: then for our second movement we bring the second driven wheel (60) on B, to 30, the second driver on A, and under the first draught, (4.46) on A, is the 2d draught on B, which you see is 8.92 nearly: then for our last movement, we bring the front roller of $\frac{8}{8}$ of an inch on B to the back roller of $\frac{7}{8}$ of an inch on A, and under the second draught 8.92 on A, we find the whole draft, 10.20 nearly on B. *Ans.* 10 20 nearly.

2. What is the draught of a carding engine whose drivers and driven wheels are as follows, viz.: the wheel on doffer shaft 32 teeth, the wheel on upper end of side shaft 28 teeth, the wheel on lower end of same 20 teeth, and the wheel on feeding roller of 140 teeth: the doffer 14 inches and the feeding rollers 2 inches in diam. *Ans.* 56.

First driving wheel,	32	First driven wheel,	28
Second do.	20	Second do.	140
Diam. of feed. roll.	2	Diam. of dof.	14

Here, as in the last example, we have 6 terms given to find 1, and of course the same mode is pursued.

Then, our first movement will be to take the first driven 28 on B, and bring it to 32, the first driver on A; then under 1 on A we find the first draught 1.14 nearly on B: then our next movement will be to bring the second driven wheel 140 on A to the second driver 20 on B, and over the first draught 1.14 on B, we find the second draught 8 on A: and our last movement is to bring the doffer of 14 inches on B to 2 inches on A, and under the second draught 8 on A, we find the whole draught, 56 on B.

The same mode of operation is pursued when motion to the doffer and feeding rollers is conveyed by a range of wheels from the main drum axle.

3. Required the draught of the mule jenny of the following wheels, viz.:

Pinion gear on the coupling shaft,	20 teeth.	Top-carrier wheel,	116 t'h.
Change wheel,	32 "	Back rol. "	56 "
Back roller,	$\frac{7}{8}$ inch.	Front roller,	$\frac{8}{8}$ inch.
		Ans.	11.6 draught.

4. Required the draught of the ring traveler whose draught wheels are as follows, viz.:

Pinion wheel,	20 teeth.	Top-carrier wh'l,	72 teeth.
Change do.	36 "	Back roller do.	60 "
Back roller,	$\frac{7}{8}$ inch.	Front roller,	$\frac{9}{8}$ inch.

Ans. 7.07 nearly.

5. Required the draught of a machine whose draught wheels are as follows, viz.:

Pinion wheel,	21 teeth.	Top carrier wh'l,	72 teeth.
Change do.	25 "	Back roller do.	56 "
Back roller,	$\frac{7}{8}$ inch.	Front roller,	1 inch.

Ans. 8.77 draught.

6. Suppose the pinion on front roller of extenser is a 21, working into the top-carrier of 72 teeth, and the change wheel a 28, working into the back roller wheel of 56 teeth: the back rol. $\frac{7}{8}$ and the front do. $\frac{9}{8}$ of an inch in diameter: required the draught.

Ans. 7.7 draught.

Pinion wheel,	21 teeth.	Top carrier,	72 teeth.
Change do.	28 "	Back roll. wh.	56 "
Back roller,	$\frac{7}{8}$ inch.	Front roller,	$\frac{9}{8}$ inch.

Operation. Bring 72 on B to 21 on A, and under 1 on A is 3.4 nearly on B = the first draught: then bring 56 on B to 28 on A, and under 3.4 on A is 6.8 on B = the second draught; then, bring $\frac{9}{8}$ on B to $\frac{7}{8}$ on A, and under 6.8 on A you have the whole draught 8.8 on B. *Ans.* 8.8 draught.

SECTION VII.

CHANGE OR NUMBER WHEELS.

1. Suppose you are spinning 30's warp with a 36 change wheel, and it is required to spin 40's from the same rove. What change wheel is necessary?

Ans. 27.

Operation. Bring the slider (inverted, because here more requires less,) so that the change wheel 36 on C, rests under 30 on A, and under the number required 40's on A, is the change wheel 27 on C.

2. Suppose a pair of mules are spinning No. 28 weft, with a 30 change wheel, and it is required to change to 30's. What change wheel is necessary?

Ans. 28.

3. If a throstle-frame is spinning No. 24 with a 28 change wheel, and you want to spin No. 26 from the same roving, what change wheel do you require?

Ans. 22.

4. If a ring traveler is spinning No. 28 with a 30 change wheel, and you replace it with a 24 change wheel, what No. of yarn will the latter turn out?

Ans. 35.

Operation. Bring 28 on C to 30 on A, and over 24 on C you have 35, the No. of yarn on A.

5. Suppose a fly frame makes a 4 hank roving from a 30 change wheel, what sized roving, and what difference will a 24 change wheel make?

Ans. 5 hank roving, and 5—4=1 dif.

6. Suppose you have a set of extensers making a $4\frac{1}{2}$ hank rove from a 28 change wheel, and you desire to make a 6 hank rove from the same preparation, what change wheel do you need? *Ans.* 21.

7. Suppose you are making a 5 hank roving with a 26 change wheel, and you wish to make a $4\frac{1}{2}$ hank roving, what change wheel do you require?

Ans. 29 nearly.

8. Suppose you are spinning No. 40's weft with a 30 change wheel, and you wish to spin No. 45's, what change wheel do you require?

Ans. 26.6, say 27.

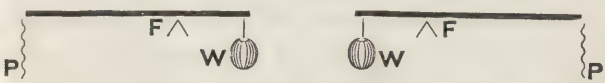
9. If a 32 change wheel will make from a 4 hank rove, No. 20, what No. of yarn will a 28 change wheel make? *Ans.* 22.8, say 23.

Operation. Bring 32 on C (slider inverted) to 20 on A, and over 28 on C is found 22.8 nearly on A.

SECTION VIII.

THE LEVER.

FIRST KIND OF LEVER.



There are three kinds of levers; *first*, that of the weight to be raised at one end, the power at the other end, and *the prop*, or *fulcrum*, somewhere between: *second*, that where the power is at one end, the fulcrum at the other, and *the weight* somewhere between; and

third, that where the weight is at one end, the fulcrum at the other, and *the power* somewhere between.

1. Suppose the long arm of a lever is 9 feet, with a weight or power of 6 pounds resting on the same: required the weight or resistance this weight will balance, the short arm being 1 foot? *Ans.* 54 lbs.

Operation. Bring the slider (inverted) so that the power (6 lbs.) on C, rests under 9 (the long arm) on A, and under 1 (the short arm) on A, you will find the resistance overcome 54 on C.

2. Suppose you move your joint or pivot so that the short arm is $1\frac{1}{2}$ ft. or 18 inches in length: required the resistance overcome? *Ans.* 36 lbs.

3. Suppose the long arm is 8 inches, with a power of $3\frac{1}{2}$ lbs. applied; required the resistance this power will overcome, the short arm being 1 inch. *Ans.* 28 lbs.

4. Suppose the long arm is 8 feet, with a power of 75 lbs. and the short arm $1\frac{1}{2}$ or 1.5 feet: required the resistance? *Ans.* 400 lbs.

Operation. Bring the power 75 on C, to the long arm 8 on A, and under the short arm 1.5 on A, you perceive the resistance overcome 400 lbs. on C.

5. Suppose the long arm is 6 feet, with a power of 400 lbs. applied; required the resistance this power will overcome, the short arm being 9 inches or .75 of one foot? *Ans.* 3200 lbs.

6. Suppose the long arm is 10 inches, the power 6 lbs., the resistance 15 lbs.: required the length of the short arm? *Ans.* 4 inches.

Operation. Bring the power 6 lbs. on C, to the long arm 10 inches on A, and over the resistance 15 lbs. on C, you perceive the short arm 4 inches on A.

7. Suppose the long arm is 7 inches, the power 5 lbs., and the resistance 8 lbs.: required the short arm?

Ans. 4.38 inches.

8. Suppose the resistance is 25 lbs., the short arm 3 inches: what is the long arm, the power being 5 lbs.? *Ans.* 15 inches.

Operation. Bring the resistance, 25 lbs. on C, to the short arm 3 inches on A, and over the power 5 lbs. on C, you have the long arm 15 inches on A.

9. Suppose the resistance is 40 lbs., the short arm 4.5 inches: what is the long arm, the power being 9.5 lbs.? *Ans.* 19 in. nearly.

10. Suppose the resistance to be 150 lbs., the short arm 1.5 inches, and the long arm 15 inches: required the power? *Ans.* 15 lbs.

Operation. Bring the resistance 150 on C, to the short arm 1.5 on A, and under the long arm 15 on A, is 15 on C.

11. If the resistance is 1000 lbs., the short arm 2 feet, and the long arm 16 feet, what is the power?

Ans. 125 lbs.

SECOND KIND OF LEVER.

1. Suppose a lever is 12 inches, with a power of 5 lbs., what is the resistance, the short arm being 2.5 inches? *Ans.* 24 lbs.

Operation. Bring the power 5 lbs. on C, to length of lever 12 inches on A, and under the short arm 2.5 inches on A, you have the resistance 24 lbs. on C.

2. Suppose the short arm is 3 inches, the resistance 12 lbs. and the power 4.5 lbs.: required the length of your lever? *Ans.* 8 inches.

Operation. Bring the resistance 12 lbs. on C, to the short arm 3 inches on A, and over the power 4.5 lbs. on C, is the length of the lever 8 inches on A.

3. Suppose the drawing-frame rollers require to be weighted 18 lbs., and you want to use a lever 6 inches long, with the fulcrum $\frac{3}{4}$ or .75 of an inch from the end: required the weight or power?

Ans. 2.25 lbs.

Operation. Bring your weight 18 lbs. on C, to the short arm .75 of an inch on A, and under the length of lever 6 inches, on A, you have the power required 2.25 lbs. on C.

4. Suppose you wish to weight the rollers of a mule

16 lbs. with a lever 5 inches long: required the power to be applied, calling the short arm $\frac{1}{2}$ or .5 of an inch.

Ans. 1.6 lbs.

5. If the steam engine valve requires a weight of 35 lbs on a 12 inch lever, what weight must you suspend on the end of same to produce it, the fulcrum or short arm being 3 inches from the other end?

Ans. 8.75 lbs.

6. If the lever of an engine is 10 inches, with a power suspended of $5\frac{1}{2}$ or 5.5 lbs., the resistance 35 lbs., what is the length or distance of the fulcrum from the shorter end?

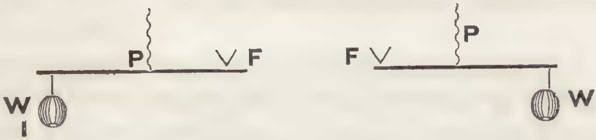
Ans. 1.57 feet, or $1\frac{6}{10}$ nearly.

Operation. Bring the power suspended 5.5 on C, to length of lever 10 on A, and over the resistance 35 on C, is the length of short arm 1.6 nearly on A.

7. Suppose you have a lever 12 feet long and apply a power equal to 250 lbs. and you wish to raise a weight of 6000 lbs., what distance from the end of lever must you place your fulcrum?

Ans. 6 in. or .5 foot.

THIRD KIND OF LEVER.



1. Suppose the power to be 300 lbs., the short arm $\frac{3}{4}$ of a foot or 9 inches, and the length of lever 12 feet; required their resistance? *Ans.* 18.75 lbs.

Operation. Bring the power 300 lbs. on C, to the short arm, .75 of a foot on A, and under the length of lever 12 feet on A, is the resistance $18\frac{3}{4}$ lbs. on C.

2. Suppose the power to be 450 lbs., the resistance 100, and the length of lever 11 feet: required the short arm? *Ans.* 2.44 feet.

3. If the length of a lever is 14 feet, the resistance 110 lbs., what distance from the joint or end must you place 500 lbs. to balance or sustain the resistance? *Ans.* 3.08 feet.

SECTION IX.

THE PULLEY.

1. Required the weight balanced by a power of 30 lbs. made fast to a rope passing over two movable pulleys? *Ans.* 120 lbs.

Operation. Bring 4 (double the number of pulleys) on B, to 1 on A, and under the power (30 lbs.) on A, is the weight 120 on B.

2. Required the weight balanced by a power of 150 lbs. made fast to a rope passing over 8 movable pulleys? *Ans.* 2400 lbs.

3. Required the power to balance a weight of 100 lbs. made fast to a rope passing over 4 movable pulleys? *Ans.* 12.5 lbs.

4. Suppose a drum upon a certain shaft 24 inches diam. to make 150 rev. per minute, which is driven by a first drum: required the diam. of the pulley on ring-frame cylinder, to make 480 turns in a minute? *Ans.* $7\frac{1}{2}$ inches.

Operation. Bring 24 on A, to 150 on C, and under 480 on A, you have $7\frac{1}{2}$ or 7.5 on C.

5. Suppose a drum upon a first mover to be 20 inches in diam., making 60 revolutions per minute, required the diameter of last drum to make 300 revolutions? *Ans.* 4 inches.

6. Suppose 1000 lbs. to be hung to a pair of blocks of 10 pulleys, (one-half being loose,) what weight must be hung to the last pulley in order to balance them? *Ans.* 10 lbs.

STATISTICS OF MANUFACTURING DISTRICTS.

LOWELL.

This is the largest manufacturing place in the country. It is well laid out, and is fast increasing in population, manufactures and wealth. Here are turned out some 80,000,000 yards of goods yearly, consuming 25,000,000 pounds of cotton, and over 1,000,000 pounds of wool, &c. &c.

In 1845, there were eleven corporations, with an aggregate capital of nearly 11,000,000 dollars; some thirty-three mills, exclusive of print works, &c., employing nearly 9000 hands. Since then it has increased, and promises to expand and reward, in a greater degree, its founders and their representatives.

The Lowell Courier, a spirited paper, in speaking of its business prospects, says, "There are few cities in the union which have grown up and assumed an importance in the business world, as suddenly as our own. Twenty-five years ago the spot on which this beautiful city stands, was a barren waste. Now we number about 27,000 inhabitants. Though our growth has been sudden, it has been healthy; it has been the result of Massachusetts capital, Massachu-

setts enterprise, and Massachusetts foresight, disconnected entirely with speculation, or hazardous or doubtful experiment. The founders of this city were men of character and of solid means; and it is a gratifying fact that from the first commencement of our manufactures here, until the present hour, not one of the thousands of operatives who have labored for the corporations, has lost of his or her fair earnings, the value of a sixpence. Lowell has become the second city of New England, and we are gratified to learn that the star of her destiny is yet rising, and is not yet near its culminating point."

This city may well be called the Manchester of America, both from its amount of capital and number of manufactories, and from its being the central point in New England of this important branch of our industry. Here may be seen what in vain we find in the workshops of Birmingham, or in the streets of Paisely or Glasgow, a host of men and a greater number of the 'better half,' who are respected as human beings, and whose moral power is felt and acknowledged, and who have bread enough and to spare. Here is displayed a kindness of heart, a generosity of feeling, and a devotedness of zeal between men and men, which have elevated the 'city of spindles' high on the scale of moral excellence, caused her to shine as a star of the first magnitude, and signalized her growing loveliness with the most happy results. Here too, while industry and devotedness are her offerings at the loom, may be found the workings of more than ordinary genius in the mind of many a female. In

beholding her commanding eminence, and listening to the hum of the spindle, the clash of the loom, and the rich music of her dashing water-falls and chiming bells; in gazing upon her prosperity, her beauty, and her increasing strength, who of us does not feel proud that it is our own, and who of us but wishes success—success to the Manchester of America?

LAWRENCE CITY.

This promises, at no distant period, to become one of the largest manufacturing districts in our country. Mills have sprung up like magic, and capitalists are developing its resources. It is beautifully located, and like all Massachusetts enterprise, goes ahead with energy and rapidity.

Another district to which the above remarks justly apply, is found at Hadley Falls. There is not a doubt that it will outstrip Lowell in this branch of our industry. Success attend it.

NEWBURYPORT, MASS.

This town, situated in the extreme east of the state, contains quite a number of mills, which turn out as handsome goods as any in this or any other country. This is a healthy, growing place, and is deservingly celebrated for the enterprise of its inhabitants.

CABOTSVILLE.

This is quite an extensive manufacturing district, and is beautifully laid out. Speaking of its rapid growth, Mr. White, in his Memoir of Slater, says: "It has grown up with astonishing rapidity, and bids fair to become, at no very distant day, a second Lowell."

"The water power at this place is immense, and as yet, scarcely begun to be occupied. There is a neatness, too, and good taste, in the location of the streets, and the arrangement of the buildings, which is not common in manufacturing villages. The cotton factories are extensive, and in appearance resembling those at Lowell."

There are other villages but a little distance from this, marked with a peculiar degree of taste and simplicity.

FALL RIVER.

This town, in July, 1843, was visited by one of the most destructive fires that ever occurred in New England. Since then, it has been re-built with greater splendor and a more refined taste, and now is one of the most prosperous and spirited manufacturing districts. Most of the mills are situated on a descending point, one below the other, and form quite an imposing appearance. The water, as it leaves the upper mill passes directly to the others.

A variety of manufactures are here turned out, con-

sisting of cotton, woolen and printing goods, extensive nail and other iron works, together with numerous mechanical implements, &c. It is a growing place, and is distinguished alike for the beauty of its location, and the enterprise of its inhabitants.

Other manufacturing districts in this, as in other parts of our country, are found scattered along beside most every stream. These our limits forbid us to mention. A few of the most important in a number of the states will be given below.

PATTERSON, (NEW JERSEY.)

This is a flourishing district, and next to Lowell, is one of the most extensive in our country. Beside numerous cotton, and other manufactories, here are found some of the greatest machine shops and iron works of America. And it is not saying more than can be substantiated, that machines are here turned out, that will vie with the most elegantly finished of those of Manchester.

The water power here is unfailing, being the vast sheet of the Passaic ; and it has been found that between the distance of four miles, viz., between Great and Little Falls, there is a fall of some 145 feet, capable of driving upwards of 300 undershot water-wheels. This place, it would seem, is destined as a star of peculiar beauty in the galaxy of American manufactures.

SACO, (MAINE.)

At this place are a number of elegant factories for making striped and mixed jeans, drillings, tickings, &c., managed with distinguished ability. The facilities for manufacturing at this place are superseded by no other of this country. The Saco river, in the driest seasons, is fed by the melting snow from the summits of the White Mountains, proving a never-failing reservoir, and sufficiently capable of operating from twelve to fifteen of the largest factories. The transportation to the great Atlantic city, too, is quite limited in its expense, when compared with a great proportion of our establishments, being but from ninety cents to one dollar per ton. Many other advantages combine to render this location attractive to the capitalist and manufacturer.

The Kennebec river, (across which is completed a dam,) is thought by competent judges to be capable of driving more than one hundred factories.

GREAT FALLS, (NEW HAMPSHIRE.)

In entering this beautiful village, one is forcibly struck with the beauty and uniformity of its appearance, and the precision with which it is laid out. Quite a number of mills extend along in a straight line but a few rods from each other, as also do the neat dwellings of the operatives, surrounded by a court planted with beautiful trees. Much taste is displayed in the management of this lovely village. From twelve to fifteen hundred looms, or upwards, are here operated.

DOVER, (N. H.)

Here are found quite a number of respectable factories, so situated as to form a block or square. Many excellent printing goods are made and stamped ready for market. The Dover Prints bear the most rigid scrutiny and competition. Like many of the New England villages, it is one of rare beauty and retirement.

At Manchester, Nashua, Portsmouth, Little Falls, etc., there are in operation many deservingly celebrated mills, and there are sites for upwards of seventy-five more of the largest class.

MATTEAWAN, (N. Y.)

Very superior machines, and other manufactures, are here turned out, reflecting much credit upon the owners.

The Matteawan Machine Company furnish as good machines in every respect, as those made in Glasgow or at any other place in Britain.

Many factories are found scattered over the "Empire State," the larger of which are on the Hudson and its branches.

SMITHFIELD, (R. I.)

This is one of the largest manufacturing towns in the state, and is rendered peculiarly attractive from the number and neatness of its villages. Probably there is not another district in the Eastern States,

where can be found connected a greater amount and variety of business than along the valley of the Blackstone. Commencing at Providence, and following this river for more than thirty miles, the traveler barely passes one village before another is presented to his view full of life and motion.

Among the numerous establishments which may be found in operation along this valley, are those of Pawtucket, a flourishing town, and the birth place of American manufactures, the Central and Valley Falls, the Lonsdale and Blackstone Companies, the Slatersville and Varnum's, the Woonsocket Falls Company, and other large mechanical works of unsurpassed extent and value.

Besides the above concerns, there are found others of as great importance in various parts of this state, such as are in Coventry, Warwick, Johnston, Scituate, North Providence, Warren, Newport, Bristol, &c. &c.

NORWICH, (CONN.)

In this town are found quite a number of extensive manufactories, the principal of which are at Greenville and "The Falls." At the former village are the Thames, the Shetucket, the Greenville Companies, beside carpet, paper, dyeing factories, machine shops, foundries, &c. This place is noted for its rapid growth, and the neatness of its appearance.

At "The Falls," on the Yantic, are a number of elegant mills and other manufactories, conducted with much foresight.

Other mills are scattered along most every stream in this state. The Quinebaug and other smaller streams in the eastern part, operate numerous establishments, such as are situated in Willimantic, Pomfret, Killingly, Thompson, Plainfield, Griswold, and other towns.

CINCINNATI, (OHIO.)

This great emporium of the West, destined to become the "shining star" of America, already contains a number of cotton and other manufactories, which are deservingly celebrated.

Other factories are being put into operation in many of the towns near the Ohio, which are exceeded by none in our country.

The cotton manufacture is carried on to a considerable extent in the Middle and Southern States. And there can be no doubt, that in less than twenty-five years, this portion of our country will have become the greatest cotton manufacturing district in the world! This is a strong assertion; but it is fortified by the most reasonable circumstances. The cheapness of labor, the vast forests of the Carolinas, the immense water power, the numberless and as extensive iron, coal, and other mines, the over-producing and still increasing amount of raw material, the limited transportation and growing facilities for a ready market, (all guided by Yankee enterprise,) combine to make the South peculiarly adapted as the great cotton manufacturing, as well as cotton producing, granary of the world.

True, as yet, the Northern and European manufacturers are formidable competitors, and will for a season continue so to be; but who is prepared to discredit the advancement we have made? Who, with a reflecting mind, in this wonder-growing country, is prepared to prove the falsity of our more than probable statement?

With candid reflection as our guide, who of us dare predict the unfolding of nature and art within a quarter of a century in the destinies of the Western world? Seeming impossibilities, and fortresses as impregnable as Gibraltar, in the estimation of our forefathers, have been demolished and scattered to the winds by their children! The wild woods of the "far west," once the abode of the savage man and beast, deemed by our ancestors as a dreary and cheerless waste, have been explored by their posterity, and the sun in his course sheds not more genial rays upon, or beholds a more fruitful land than ours!

The spirit of improvement, with the mantles of Watt and Franklin and Morse as its talisman, has brought our vast republic into a neighborhood, and enabled us to hold sweet converse with beings from one extremity to the other.

The dashing rivulet, the waving forest, and the wonder-working fire of the lightning, with which our philosopher delighted to play, are made our ministers in conveying our directions, our wills and our thoughts! And our huge and untiring monster of the land, the iron horse, fed by naught but vapor and blaze, obedient both to man and child, delighting to chase the lark in its flight, or to pull with Hercules the solid

base, ready to drain the deepest river, to march triumphantly over mountain-high billows, to finish the tiny needle, in short, almost sufficient to accomplish the will of man, is only the forerunner of a mightier agent, (as yet in its infancy,) destined to brave all, to overcome all.

Twenty-five years!—and what scenes will be presented to the American! He will behold the unexplored region bounded by the Pacific—a world by itself—crowded by human beings, united in our confederacy, and linked to the Rock of Plymouth by an iron chain. He will behold 40,000,000 of human beings, the most devoted, the most beloved, the most respected of any on the face of the earth. He will find along the valleys of the western rivers, the greatest agricultural country on the globe. In the South and East, he will behold *the most extensive manufacturing district in the world.* He will find every city of "the Union" connected with a railway. He will find that news can be transmitted from Astoria to Eastport, from thence to New Orleans and back again to its origin, in one day. He can transact his business with any city while seated in his own counting-room. He will employ wings, wind, vapor and other agencies, as yet almost unknown, to transport his person, his interests, from one end of the republic to the other. He will behold *the greatest commercial, the wealthiest, the most enterprising, the most successful, and withal, the happiest people in the whole world.* In short, we repeat, who of us dare predict what we may not be permitted, in our admiring wonder, to gaze upon?

Date Due
